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JOURNAL

SANITARY ENGINEERING DIVISION

Proceedings of the American Society of Civil Engineers

SANITARY ENGINEERING DIVISION,
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JOURNAL

SANITARY ENGINEERING

Proceedings of the American Society of Civil Engineers

SANITARY ENGINEERING PROGRAMS OF THE I. C. A. IN THE N. E. A. AREA

Vincent B. Lamoureux,[1] M. ASCE
(Proc. Paper 885)

Properly, the subject of this paper should be concerned with environmental sanitation, rather than sanitary engineering. More, the title given should reflect the change in the name of the agency to the International Cooperation Administration from the Foreign Operations Administration. Briefly, technical assistance has been given to the underdeveloped countries of the world at their request since the creation of the Economic Cooperation Administration in 1948. The ECA was abolished by the Act creating the Mutual Security Agency in 1951. In turn MSA was abolished in 1953 and its functions were transferred to the Foreign Operations Administration. The present agency, International Cooperation Administration, was officially organized on July 1 of this year, replacing FOA. The Technical Cooperation Administration, under the administration of the Secretary of State, was created by authority provided under the Act for International Development approved in 1950. TCA was more familiarly known as "Point IV." This Act provided for the "international exchange of technical knowledge and skills designed to contribute to the balanced and integrated development of the economic resources and production capacities of economically underdeveloped areas." The Institute of Inter-American Affairs, originally established under another name in 1940, was an integral part of TCA and was transferred to FOA along with TCA in 1953. As it is concerned entirely with Latin America or, more properly, the countries and dependent occupied territories south of the United States, this paper does not deal with it. Both MSA and FOA functioned as independent agencies reporting directly to the President. ICA is a semi-autonomous agency within The Department of State and its Director reports to the Secretary of State.

The International Cooperation Administration is divided into three offices; one for Management, a second for Operations, and a third for Technical Services. The Public Health Division is a part of the organization of the Office for Technical Services. Geographically, the Division follows the pattern set up by the Office for Operations, so that there are three branches, one for

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Latin America, one for the Far East, and one for Africa, the Near East and South Asia. There is no branch for Europe, as there are no ICA public health programs operated by our Mission to the countries in Europe.

The NEA area covers all of Africa excepting the Union of South Africa and that part of Northern Africa which is considered by France to be an integral part of the Republic; the Near East, including Greece, Turkey, and Iran; and South Asia, which includes Afghanistan, Pakistan, India and Nepal. There are presently public health programs, including sanitary engineering, in the four free countries of Africa; namely, Liberia, Libya, Egypt, and Ethiopia, and two of what are usually called Dependent Occupied Territories; Kenya and Nigeria. There are no sanitary engineering programs in these last two territories. In the Near East, there are sanitary engineering projects in Israel, India, Lebanon, Iraq and Iran. There had been programs in malaria control in Turkey under MSA and in malaria control, environmental sanitation, water supply, and waste disposal in Greece under ECA and MSA but none under FOA or at the present time. Syria has not had a program of health assistance and the Saudi Arabia Mission closed in October, 1954. Iran and the South Asian countries all have environmental sanitation projects varying to considerable degree. As stated earlier, all these projects in the public health field have been in environmental sanitation rather than sanitary engineering per se. However, there have been developments in sanitary engineering under auspices other than public health which I will cover later in this paper.

This presentation, preliminary to actual discussion of the program in sanitary engineering in the area, is long but it does provide necessary background to define the area covered by this paper and the authority under which we operate. Each country has an Operations Mission, divided into several divisions, one of which is the Public Health or the Health and Sanitation Division. The chief of this division is usually a medical officer, experienced in public health administration. On his staff there are one or more sanitary engineers depending upon the size of the country, the size of the program and the monies allocated for carrying out the sanitation and sanitary engineering projects. Again, the extent of these projects depends upon the contribution made by the host country, in cash, personnel and facilities.

In general, the problems in all these countries are quite similar in that we are dealing with ignorance, poverty, malnutrition, disease, and poor environment. The ignorance is not due to a lack of intelligence but to a lack of educational opportunity for the masses. Poverty is due to the traditional systems under which many of the host country nationals have been living, a status in life which has been accepted and which, until recently, little has been done to alleviate. Malnutrition follows where there is poverty and disease but, strangely enough, sometimes occurs through a failure to recognize the value of native foodstuffs which have never been utilized. Disease is rampant and many of these diseases are those all susceptible to control by proper environmental sanitation and sanitary engineering activities. Respiratory infections, eye infections, the diarrheas and dysenteries, and many of the parasitical diseases may be controlled and even eliminated by proper sanitary measures. Malaria is prevalent in all these countries. Schistomiasis extends along the north shore of Africa through the Middle East into Iran. Diarrhea and dysentery are common. Trachoma and conjunctivitis are serious in many of these countries. Add to these hookworm, guinea worm, filariasis and other

parasitical diseases, the load of illness and disability carried by the populations becomes enormous. It is said of one country that there are ten common diseases and that any one person suffers from three of them at one time. No mention is made of the chronic diseases which frequently can be helped by improvement of the environment.

Living conditions outside the large cities are too frequently deplorable. The wealth of the countries has concentrated in its cities and these in turn have provided their wealthy clientele with many modern improvements including public water supplies, sewer systems, refuse collection and disposal, street sweepers, paved streets, fire-fighting apparatus, police services and all that goes with modern municipal administration except adequate health services. Sanitary engineering as a part of a State or municipal health service was virtually unknown till a few years ago. Yet some of these cities have now outgrown their original utilities and facilities. In a few instances they lack a modern water supply system and one very large city is literally floating on cesspools. They are aware of their shortcomings and are seeking engineering advice and consultation, preferably from U. S. firms. One problem is to get the information out of the appropriate officials so that invitations may be sent to consulting firms and contracts entered into which are not supported by U.S. funds.

The economy of the countries is invariably agricultural with 80 per cent or more of the population living in rural areas. Some of the villages are larger than many of our smaller cities. Yet the need for sanitary improvements is greater in these villages. The need for water is paramount. The Muslim people are basically very clean in their habits in that the Koran requires them to wash frequently and to use soil for cleansing purposes when water is not available. And water, in quantity to serve all but minimal needs, is not available. We think in terms of 50 or more gallons per capita per day. In many of these countries, the actual use is less than one gallon per capita per day. Where water is available in quantity, as along the Niles, the Euphrates or the Sind Rivers, it is also grossly polluted and dangerous, if it is used without treatment.

In general, the environment of the village is never good, despite the cleanliness which is common in the individual household. Human wastes are deposited in street corners, along designated walls or in designated fields or areas, without attempt to control or to prevent fly-breeding and the transmission of disease by flies, fleas or other vectors. Animal manures are allowed to accumulate and add to the breeding areas of the ever present fly. Some of these manures are used as fuel, others simply pile up and are not used for fertilizer or humus in a poor, nutriment-starved soil. There are little of other wastes as the people will use nearly anything, but what there is simply thrown out to be kicked around, broken to bits and trampled into the dirt of the village street. Housing is inadequate, frequently without chimneys to permit the escape of smoke, and usually with provision for animals to live inside as a protection against their loss. The first task then, to be undertaken before any sanitary engineering activity is possible, is to bring into each community some understanding and undertaking of environmental sanitation and hygiene in the home. Even before that, it is necessary to train sanitarian aides in the rudiments of basic sanitation; secure their employment by the Government; and send them out into the rural areas to start the clean-up necessary for an

improvement in the living conditions and in the health of the people. It should be noted early in any program dedicated to better health in any of these countries that rural areas need attention first, not only because the rural villages require improvement but because improvement in the cities will only attract people from these rural areas more rapidly than the municipal authorities can keep pace with the demands to extend and maintain their facilities and utilities. Slums which may have been cleaned up are simply created elsewhere.

It should not be construed from these statements that criticism of these countries is intended or implied. Public health—the prevention of disease—is new to most of them. All are deeply interested, realizing that one of their most valuable resources is a healthy population. All are putting money and men into the health programs in their country, as well as providing necessary facilities and transportation. Health in the past has meant medical care and they do have tremendous tasks in providing even limited medical facilities for their indigent, sick and disabled. They have lacked the knowledge to tackle the control of disease by preventive measures and have welcomed the U. S. technicians who are bringing this knowledge and the ability to use it to them. Their personnel at sub-professional levels are being trained by these technicians in the field, mainly by demonstration. Their professional personnel are being sent to the U. S., Canada, Europe, and the American University at Beirut for the education and experience required to qualify them for public health administration and operations. It has been the objective of ICA and its predecessors to provide a basic public health team consisting of a medical officer, a sanitary engineer, a public health nurse, a public health educator, and an administrative officer to bring to each country the fundamentals of a sound public health program in public health administration, communicable disease control, environmental sanitation, public health nursing, maternal and child health, and the education of the public in public health concepts and operations. To a great extent, ICA has succeeded in providing, with country consent, this demonstration team—with country consent, because no program is entered into without agreement with the host country and no technician is sent without country concurrence.

It may be best at this point to discuss each country in which we are operating and give you some indication of what is being carried on in the field of environmental sanitation and what the prospects are for sanitary engineering developments in each country.

Liberia: This small country on the West Coast of Africa has had some sanitation programs for more than 12 years. The Public Health Service sent personnel over, primarily for malaria control, to provide public health protection for U. S. personnel stationed at bases established there during World War II. Malaria control has continued, principally around Monrovia, the capital. But control measures have been largely under the direction of entomologists and have been limited to the control of adult mosquitoes by residual spraying of homes and other resting places with DDT and Dieldrin. Some larviciding has been done. No control by drainage or filling has been done or is likely to be attempted in the near future. Environmental sanitation has been very limited in scope in the past and for the present will be carried on largely at two rural health demonstration centers in the hinterland. One of

these is to be located in an area afflicted with trypanosomiasis—sleeping sickness—in an attempt to learn to control it as any other communicable disease. Caused by the tsetse fly, control may be secured by treatment of the patient with drugs or by control of the breeding and resting areas of the fly. Selective clearing has been successfully done by the British in nearby areas for the control of the domestic tsetse fly, which is the carrier of the disease affecting humans. No effective method of control, other than indiscriminate dusting of areas by planes, has been found for the wild types of the fly. Sanitary Engineering administration appears to be required in the selection of areas, their mapping, methods for cleaning, and the selection of equipment. Monrovia is a small city with sanitary utilities and facilities. There are no other cities of a size large enough to demand modern sanitary utilities. Developments by U.S. industrial firms investing in Liberia's natural resources are handled by the companies concerned. There does not appear to be any requirements for sanitary engineers in Liberia beyond assignment to the Public Health Division of the Mission in the near future.

Libya: The major portion of this country's population is spread in a thin strip along the coast. There are two major cities: Tripoli and Benghazi. Water is the greatest need. Trachoma is the greatest disease problem with about 90 per cent of the population affected. More water, readily available to the population, and better living conditions will do much to reduce the incidence of trachoma. There are two sanitary engineers and three sanitarians attached to the public health staff of the Mission. Sanitary engineering has been limited to the development of village water supplies from wells and springs. There will be a few limited distribution systems, with elevated tanks, for demonstration purposes. There is some discussion of reclaiming the sewage of Tripoli and Benghazi for irrigation usage. Beyond that there does not appear to be any probable demand for consulting engineering services.

Egypt: Egypt's cities have both public water and sewer systems. Presently they are faced with population growths which are causing the cities to review their requirements and plan for overhauling their existing systems. There is need for complete surveys as many of the old records seem to be incomplete. Modernization of treatment facilities will be required in a few years. The Mission's sanitary engineering staff is limited to two engineers. They are engaged in the development of sanitary engineering as a function within the Ministry of Health, of handling engineering and sanitation activities of the rural public health demonstration center at Shubra Mant, and in providing advice and counsel on sanitation and sanitary engineering matters. There is a small potable water supply project, providing water supplies at the village level. There is an organization known as the Egyptian-American Rural Improvement Service, financed in part with U. S. funds, which is concerned with the provision of water to selected areas and villages to replace the polluted water of the canals and ditches. Egyptian engineers are doing the designing and supervising the installations. There is an overall contract in force with a U. S. firm which does permit subcontracting for professional sanitary engineering consultation. This was used, for example, in providing expert advice on the design and construction of an abattoir. Of particular interest to sanitation and public health personnel is the project underway to demonstrate effective killing of snails, the intermediate host of schistosomiasis, by careful

dosage of canals and ditches in a selected area with sodium pentachlorophenate. Cleaning and clearing of existing canals and ditches, better design and the application of this chemical may rid Egypt of this perennial disease attacking about 90 per cent of her population.

Ethiopia: The program in Ethiopia, until recently, was limited to advice and counsel on all public health matters given by a sanitary engineer who was originally assigned to a public roads program financed outside of ICA and its predecessor. From the start with this engineer there is now an enlarged and growing public health program including malaria control, the training of sanitarians, and the establishment, including construction of facilities, for a rural health demonstration center. Environmental sanitation is limited to demonstrations at two training centers, both of them rural. In order to provide a demonstration area in which these sanitarians, more properly sanitarian aides, it was necessary to create a provincial and a municipal health department and designate the U. S. Director of the training center as both provincial and municipal health officer. Water quantity is not a problem in the elevated mountainous parts of Ethiopia. It is definitely scarce in the arid and semi-arid stretches of southeast Ethiopia and southern Eritrea. The supply of water of acceptable quality is a major sanitary engineering task all over the country. A survey has been made of water and sewer system improvements and extensions in Addis Ababa, the capital. A detailed report, with recommendations, has been prepared but has not been received at the time of preparation of this paper. It is presumed that consulting sanitary engineers may be called in if the Government of Ethiopia and the municipality of Addis Ababa decide to undertake the required improvements. Improved methods of excreta disposal to prevent pollution of water and soil and to cut down the incidence of disease, particularly hookworm and other helminthic infestations, are required. Malaria is a serious problem in the 3000 foot to 7000 foot range of elevation, affecting improvements to agriculture, in turn affecting the economy of the country. Little is known regarding the best methods of attack against malaria and a team of two entomologists and one parasitologist were assigned a few weeks back to determine the extent of infected areas, the causative vectors, and the best methods of attack. At first, residual spraying of dwellings and out-buildings will be the method of attack. Ethiopia offers many opportunities and U. S. technicians are most welcome.

Israel: This country does not have similar conditions to overcome in that it has a surplus of educated people, physicians, engineers, and technicians, at its disposal. They need training to utilize the knowledge they already possess. There are the usual problems of water scarcity prevalent to the Middle East area. Israel is planning to utilize all waters possible, with recovery of sewage high on the list of priorities. Sanitary engineering has not been a large part of the U. S. public health program in Israel. There has been given advice and counsel at the Ministry level. A firm of U. S. engineers spent one year in reviewing existing plans and making recommendation for sewerage for eight communities including Tel Aviv, the largest city. Tel Aviv was, and is, faced with a serious beach pollution problem, affecting recreational areas and causing losses to small businesses which had hoped to capitalize on an increasing tourist trade. Improvements are now being undertaken. A sanitary engineer advisor in water supply and sewerage was assigned to the Ministry of Health

to work with the municipal engineers. He has completed his two-year tour of duty and will not be replaced. There is now left only a sanitarian training officer in the public health staff of the Mission to carry on sanitation activities. Milk and food sanitation were serious problems but pasteurized milk will shortly be available on a limited scale in Tel Aviv. Food sanitation and fly control are just beginning. Israel had proposed to carry reclaimed sewage a distance of over a hundred miles into the Negev. A recommendation has been made that well-water be piped to the Negev because of the danger that communities and families adjacent to any water line or channel will use the water regardless of source. The reclaimed sewage would be spread over selected areas to replenish the ground water. Whether or not this recommendation will be carried out is not known at this time. Sanitary engineering at the Ministry level is being carried on with some difficulty, primarily because salaries paid are at such level that engineers frequently seek employment outside of Israel long enough to recoup their losses and save enough to permit their return to duty with the Government.

Jordan: One of the early chiefs of the health and sanitation division of the Mission to Jordan was a sanitary engineer. Under his administration and the agreements reached with the Hashemite Kingdom of Jordan, considerable construction was undertaken, including improvements to the water supply of one of the smaller cities and the construction of a demonstration sewage disposal plant at another. A survey with recommendations for improvement of the water supply and distribution for the city of Amman was made. The recommendations were carried out and Amman's water supply is now rated among the safer supplies of the area. Sanitarians trained at the American University at Beirut are being actively used in a limited environmental sanitation program which covers the entire country. A demonstration health center, including environmental sanitation has been planned and awaits staffing to start its work. The refugees resulting from the dislocation of Arab families in the creation of Israel as an independent State have mainly settled in Jordan and offer a major problem handled by The United States Relief and Work Administration. The sanitation of refugees' camps and malaria control are its major sanitary engineering activities. The proposed development of the Jordan valley, should it become feasible, will provide many projects for the development of domestic water supplies. Exploratory well-drilling for irrigation sources has developed a few domestic sources of water requiring protective measures to assure their safety. There are no large sanitary engineering projects presently under consideration.

Lebanon: This small country at the eastern end of the Mediterranean is often called the gateway to the Middle East. In a truer sense, it is a gateway into the Arab world for Lebanon is the closest to the Western world in its culture, its adoption of Western ideas and its acceptance of Western methods of operations. The country is almost equally divided between Muslim and Christian. Despite all this, sanitary engineering at the government level has not yet had wide acceptance. There are sanitary engineers and civil engineers with sanitary engineering education and experience employed by the Ministry of Public Works but none in the Ministry of Public Health. On the U. S. Operations Mission staff there are two sanitary engineers, one employed as Chief Sanitary Engineer and now the Chief of the Health and Sanitation Division, the

other as a water works specialist with the Natural Resources Division. A third engineer to assist the chief of the Health and Sanitation Division has been requested. Considerable advice and assistance, including layouts, has been given in the development of small facilities, such as water supplies, sewage disposal plants and abattoirs. Sanitarians in the employ of the government have been quite widely used and their work has been directed in large part by a U. S. sanitarian on the staff. A major development in the sanitary engineering field has been that of assistance in the design and construction of village water supplies under the responsibility of the Natural Resources Division. The main part of the engineering work has been done by Lebanese engineers under the general supervision of U. S. engineers. A contract for U. S. consulting engineering services in connection with this project fell through because of a decision on the part of the Government of Lebanon to supply the required engineers. The U. S. dollars saved were used to buy U. S. equipment and materials. A proposed development of the Litani River will probably include water supply and waste disposal projects. An interesting sidelight is the development of and teaching of courses in sanitary engineering at the American University at Beirut by the engineering staff member of the Health and Sanitation Division.

Iraq: Sanitary engineering in Iraq has been rather limited in scope. The chief sanitary engineer on the Health and Sanitation staff at Baghdad was first assigned to the city of Baghdad where he made some surveys, reports and recommendations. Then he was engaged in the development of a program of food sanitation and the training of municipal sanitation personnel in the techniques of inspections and enforcement. At last reports he has been making a country-wide survey of sanitary engineering needs with particular emphasis on improved water supplies and of waste disposal. A second sanitary engineer is assigned to a health demonstration center at Basra. As this center serves the equivalent of a province, his duties have included all sanitation activities, as well as advice and counsel on water supplies, excreta disposal, malaria control, vermin control, and others. There are two sanitarians assigned to the Mission; one stationed at the center in Basra, and the other assigned to the village improvement program. I have no information on the programs of development of ground waters or improvement to surface water irrigation supplies. Both of these unavoidably serve as village water supplies. There have been studies made of requirements for improvements to the public water supplies of Iraq's cities as well as for the collection and disposal of sewage. So far, U. S. engineers have not been employed in these studies nor has any progress been made toward the requirements of these communities.

Iran: Public health administration in Iran, according to U. S. ideas, has progressed further than in any other country in this area. Advice and counsel, including that of sanitary engineering and of environmental sanitation, has been provided at the central government level to the Ministry of Health and at provincial (ostan) level in eight of the ostans. Sanitary engineering has been largely limited to the development of small water supplies, limited distribution systems and community bath houses. There have been some excreta disposal projects and a very successful malaria control program reaching nearly all of the affected population. Training of village sanitarians has been a major part of the program. In Tehran assistance has been given in the

development of a modern, treated water supply to replace the mountain waters feeding the city through an intricate system of jubes (open channels). A milk pasteurization plant has been provided Tehran by UNICEF with an ICA contribution of a protected well to provide safe water for its operations. Gradually U. S. trained Iranian engineers are assuming responsibility and U. S. participation in sanitary engineering and sanitation projects is being reduced.

Afghanistan: With the exception of a few weeks, the only public health technician in the Mission during the past two years has been a sanitary engineer. The Government of Afghanistan has been undertaking a very large power and irrigation development in the Helmand Valley in the Southwest corner of the country. Financed with loans from U. S. sources and constructed by U. S. engineers, the Helmand Valley development is intended to provide far lands for nomadic tribes. ICA under agreement is providing technical information and guidance, including public health, for these villages. So the engineer has been concerned with improvement to water supplies, sanitary methods of excreta disposal, food handling, and the multitudinous problems arising from housing construction and the rehabilitation of a hospital to provide better facilities for medical care. Beyond advice and assistance to the Ministry of Health at Kabul, and some assistance to a new community development demonstration, there does not appear to be any prospect for an enlarged sanitary engineering program or a demand for increased sanitary engineering services in the near future.

Pakistan: Public health assistance in Pakistan has developed more toward the improvement of their colleges and schools to produce competent technicians to meet their needs rather than in operations including demonstration centers. To date sanitary engineering has not been included among the disciplines for which assistance has been requested. Under contract with the Commonwealth of Massachusetts, the State Department of Public Health is providing public health personnel. Included have been one sanitary engineer, assigned to the central office in Karachi, and five sanitarians, assigned to the V-Aid program, essentially community development. There will be an expansion of the engineering staff by at least one, assigned to East Pakistan. This country is divided into two major portions, separated by 1500 miles, by the States of India between. The problems in each section are materially different. West Pakistan is dry to semi-arid with little rainfall at best. There is a scarcity of water other than in the great rivers fed from the Himalayas. There are enormous irrigation projects. Malaria is a serious problem along these rivers and irrigation canals, particularly so in that the population also lives along these water courses. Little information has been accumulated on the urban problems other than in Karachi, the capital city. Here a large river development including power and irrigation had a natural offshoot in improvement to the municipal water supply and extension to a water distribution system designed originally to serve perhaps 500,000 people and now serving in excess of 1,500,000 persons. Under contract, both water supply and sewerage improvements are handled by the Greater Karachi Water Board.

East Pakistan presents a different picture, one of low lands cut by very large rivers, a country that is flooded annually. Mosquitoes and malaria, plague and cholera, are problems of enormous magnitude facing the country and its health workers. Malaria is ever present. Cholera and plague have

not been epidemic in recent years. Water for domestic purposes is secured from the streams or from wells in villages. Too frequently the wells are not usable because of broken parts, lost valves, malfunctioning or sheer indifference on the part of the people. The major need here is a coordinated plan to provide and maintain well-water services to meet village needs. Malaria control needs to be coordinated and stepped up with some possible provision for beginning permanent measures for the control of mosquitoes. Nothing is proposed at this time beyond the assignment of one or two engineers and two or more sanitarians, starting at village level to improve village environments.

Nepal: Sanitation in Nepal has largely been limited to malaria control and that mainly in the vicinity of Katmandu, the capital city. There are few roads in the country so that travel is by ox-cart, horseback, elephantback, or afoot. Sanitation of the villages is badly needed. An engineer has been recruited to organize an environmental sanitation program and to train selected Nepalese in the various aspects of sanitation. There is a water supply for Katmandu but improvements have been delayed until some way is figured to get a 9000 pound piece of equipment for the waterworks from the railhead in India, the few miles over the low mountain trails to its eventual destination.

India: Sanitary engineering assistance to India by ICA and its predecessors, over more than a three-year period, covers the assignment of a sanitary engineering advisor to the Ministry of Health, who is also the Chief Sanitary Engineer of the Health and Sanitation Staff, a program engineer whose primary responsibility has been to help get into operation the huge five-year, 100,000,000 National Water Supply and Sanitation project; a professor of sanitary engineering assigned to the All-India Institute at Calcutta; an impounded-water malaria-control engineer; and a sanitarian assigned to community development activity. Malaria control has been financed in great part by ICA but U. S. technicians have not been assigned to this project. Aided with DDT, Dieldrin, and spraying equipment, more than 135,000,000 of India's 300,000,000 people have been protected. Another control program, that of filariasis, was started this year. Perhaps 25,000,000 persons are affected by this parasitical disease, carried by a mosquito other than the malaria-carrying anopheline. Control in selected areas will be attempted by drug administration and by mosquito control with whatever method is found feasible.

The National Water Supply and Sanitation program is intended to provide water and improved environmental sanitation eventually to more than 550,000 villages. The target in the next two years is 10,000 villages, using this period to train the enormous number of sanitarians for villages. Under the plan, the Government of India, the State concerned, and the individual city or village will contribute to the cost of the particular project in city or village. India lacks sanitary engineers, there being less than 25 at the present time. Their leading engineer-teacher was killed in an unfortunate airplane accident and the U. S. has supplied his replacement until India can qualify another professor. To provide sanitary engineers at central government and state levels, it is planned to train 300 civil and public works engineers at 4 or 5 centers during a three-month period of intensive instruction. To provide sanitary engineers at the municipal level, it is proposed to add one year in sanitary engineering to the required four-year course in civil or public works engineering at one of their leading universities. The problems in India are huge.

The Government of India is utilizing every resource in attempting to resolve them. She does have resources in her educated and trained technicians but her experience in the field of preventive medicine, public health, and sanitary engineering has not been long or broad enough to provide the great number of technicians required. Assistance in these fields has been requested and is being received from the U. S.

These, then, are the problems of the area and of the individual countries within the area. It has not been possible to touch upon other public health activities nor dwell upon other technicians whose work contributes to the improvement of health within each country and frequently is closely allied with that of the sanitary engineer and the sanitarian. There is neither time nor space to cover even this subject adequately. In closing I wish to pay tribute to those technicians, both engineer and sanitarian, who have and are laying the base, the groundwork, of environmental sanitation upon which the structure of sanitary engineering may be built. With the development of a good health consciousness on the part of the population, we may expect increasing demands for improvement of living conditions which in turn will require the services of our sanitary engineers for many years in the foreseeable future.

Paper 887 SA 1

JOURNAL

SANITARY ENGINEERING

Proceedings of the American Society of Civil Engineers

SED RESEARCH REPORT NO. 5

ON PILOT PLANT COMPOSTING OF MUNICIPAL GARBAGE AT SAN DIEGO, CALIFORNIA

BY The Sanitary Engineering Research Committee, Rubbish and Garbage Section

From Research Data of Eric V. Quartly, Superintendent, Sewage Treatment Division, City of San Diego, California.

Acknowledgment: The generosity and professional courtesy of the author in making this data available is fully appreciated.

Synopsis: A pilot plant investigation was completed of the feasibility of composting municipal garbage. Various methods of composting including the use of additives and grinding were tried. The economic and technical data derived are summarized, critically discussed and evaluated.

INTRODUCTION

Composting of municipal garbage and other refuse is employed at many foreign cities. In particular the Netherlands, Australia, India, New Zealand, Great Britain and South Africa have developed composting plants for some of their cities and obtained valuable operating experience.

In the United States increasing urban development has stimulated a search for new low cost methods of refuse and garbage disposal. The conservation of resources has been promoted successfully to the general public and has strong appeal as a reason for composting wastes. Some older methods of garbage and refuse disposal such as the open dump are unsanitary or otherwise generally unacceptable. The high cost of incineration and the accompanying air pollution factors has made this method less attractive. Hog feeding is

Note: Discussion open until June 1, 1956. Paper 887 is part of the copyrighted Journal of the Sanitary Engineering Division of the American Society of Civil Engineers, Vol 82, SA 1, February, 1956.

employed in some areas for disposal of garbage but sanitary and local limitations prevent universal application. For instance many cities collect mixed refuse and hence no clean garbage is available for hog feeding. Where land sites exist and can be employed for sanitary land fill or cut and cover, metropolitan communities have economically determined this method to be sound. However, land sites are in time filled up and there is difficulty finding convenient additional land. Composting because of the resulting refuse volume reduction and reclamation as a soil conditioner serves to conserve existing land fill sites.

Composting can arbitrarily be differentiated into the biological breakdown of organic matter with either the presence of or absence of free gaseous oxygen in a pile. Under anaerobic conditions gaseous odor nuisance and possibly a slower rate of organic material breakdown occurs. When there is an aerobic environment maintained through adequate turning of a pile and control of the moisture content, then odor and other nuisances are held to a minimum. Under optimum conditions it is possible to compost organic refuse in a matter of hours into a stabilized humus type material. This rapid aerobic process is difficult to achieve in a practical engineering application because of the exorbitant costs of fine grinding, frequent turning of the material and other needed operations. In general the pilot plant tests at San Diego were of the aerobic type except initial start up of the test piles when excess moisture content prevailed.

A summary of operating factors that were found desirable in composting included:

The smaller the particle size and the larger the surface area of the refuse material, the quicker the organic structure was broken down by organisms.

The moisture range for efficient aerobic composting appeared to be about 40-66%.

The thermophillic organisms may raise the temperature in a compost pile as high as 45-65°C.

A carbon to nitrogen ratio range of 18-22 was found satisfactory for composting raw refuse in the tests.

Available gaseous oxygen was supplied to the compost piles by turning the material.

Seeding of organisms can be readily achieved by introducing old compost in small quantities into a new pile.

The pH of the test piles remained above 3.0.

Detailed Pilot Plant Operation

A refuse transfer ramp was utilized to discharge the collected garbage from municipal vehicles to the pilot plant test plots. A garbage grinder was installed and necessary utilities including water and power were provided. A skip loader and other operating equipment and supplies were also available for test purposes.

The characteristics of the raw and finished material varied within the following ranges:

COMPOST PILE XII - COARSE GRIND
KELP FROM BEACHES USED AS ADDITIVE

Figure 1.

Garbage	$\%H_2O$	% N	$\%P_2O_5$	% C	C/N
Raw	68-74	2.3-2.8	1.2-1.7	46.6-51.8	18.1-22.0
Final	10-25	1.0-2.1	1.2-2.3	12.8-31.9	11.2-21.6

Twelve compost piles were established with initial weights of 5,340 through 8,340 lbs. heights of from 4 to 5 ft. and diameters 6 to 8 ft. A windrow prototype for large scale operation was also attempted. Figure 1 illustrated the turning of a compost pile with a skip loader.

After grinding the compost was wetted, turned, chemically treated for fly control, sampled and after a maximum of 90 days of composting the final product was reground or screened.

Additives tried with the fresh garbage compost included: digested sewage sludge, kelp, straw and paper. The finished compost product irrespective of additives maintained substantially the same nitrogen and phosphate content.

A summary of chemical analyses for the various test piles studied is presented in Table 1.

Table 1 (Figure 17 p. 59 SD report.)

CHEMICAL ANALYSES SUMMARY

OF

FINAL COMPOSTED GARBAGE

Pile No. and Type	Moisture %	Nitrogen %	Phosphorus % as P_2O_5	Carbon %	C/N
I - Unground No Additive	13.57	2.09	2.00	31.91	15.30
II - Fine Grind No Additive	11.36	2.00	1.33	30.80	15.40
III - Coarse Grind No Additive	20.90	1.07	1.18	14.01	13.10
IV - Coarse Grind Plus Paper	10.10	1.37	1.25	21.16	15.50
V - Coarse Grind Plus Fertilizer	19.00	1.27	1.50	18.52	14.60
VI - Coarse Grind No Additive	24.76	1.03	0.67	16.43	16.00
VII - Coarse Grind Plus Straw	15.48	1.79	0.95	38.60	21.60
VIII - Medium Grind Plus Straw	23.73	1.43	2.00	21.21	14.80
IX - Medium Grind No Additive	19.60	1.59	1.21	25.40	16.00
X - Medium Grind No Additive	22.04	1.14	1.32	12.76	11.20
XI - Coarse Grind Plus Sewage Sludge	18.50	1.51	2.28	18.62	12.30
XII - Coarse Grind Plus Kelp	19.10	1.47	1.32	31.90	21.70
Average	18.18	1.48	1.42	23.44	15.62

The pilot plant operating costs ranged from $1.56 for composting 1 ton unground garbage through $20.48 for grinding garbage and supplying a straw additive. These figures do not include the expense of supervision, plant investment and other overhead but do reflect the expense of grinding, cleanup, power, turning, wetting, fly control, additive materials, and screening when utilized.

The summary of pilot plant composting costs are described in Table 2.

Table 2 (Figure 18 p. 62 SD report.)

SUMMARY

COST PER TON

Pile No. and Type	Grinding	Cleanup	Power	Turning	Wetting	Fly Control	Screening	Additive	Cost Per Ton
I - Unground No Additive				0.46	.10	1.00			$ 1.56
II - Fine Grind No Additive	8.75	2.18	1.44	0.43	.20	1.53			14.53
III - Coarse Grind No Additive	4.43	1.77	.73	0.85	.47	1.23			9.48
IV - Coarse Grind Plus Paper	7.60	2.17	1.25	0.57	.35	1.51		.58	14.03
V - Coarse Grind Plus Fertilizer	3.81	1.90	.63	0.92	.48	1.33		3.40	12.47
VI - Coarse Grind No Additive	4.33	2.48	.72	0.81	.62	1.73			10.68
VII - Coarse Grind Plus Straw	9.33	2.67	1.53	0.57	.43	1.87		1.72	18.12
VIII - Coarse Grind Plus Straw	10.78	3.08	1.77	0.91	.60	2.16		1.18	20.48
IX - Medium Grind No Additive	9.80	2.80	1.61	1.05	.45	1.96			17.67
X - Medium Grind No Additive	9.77	3.26	1.61	.92	.49	2.28			18.33
XI - Coarse Grind Plus sewage sludge	8.32	2.77	1.37	1.11	.40	1.93		2.80	18.70
XII - Coarse Grind Plus Kelp	6.32	1.57	1.04	.86	.14	1.11		None	11.04
I - Dry Ground After Composting	3.46		.57	.45	.10	1.01			5.59
I - Screened After Composting				.45	.10	1.01	4.88		6.44
								Average	$12.79

Discussion

These San Diego, California, garbage composting tests provide practical information applicable to american engineering practice. They were not basic studies performed for theoretical purposes. The need for empirical investigations to determine operating factors and costs for US conditions has long been felt. These tests provide valuable operating data.

A review of the cost data indicates clearly that composting is more costly then land fill and in order to be competitive with other refuse disposal systems requires economical and efficient materials handling. Land fill for disposing of refuse can be achieved for as little as $0.50 - $1.50 a ton of raw

material. Incineration may cost as much as $3.00 - $5.00 a ton because of the high capital first cost and the operating expenses required for handling the raw refuse materials and combustion products. Precutting of refuse prior to incineration has proven to be an exorbitant and impractical undertaking. It is doubtful if it will be economical to precut compost raw material. On the other hand following composting the finished product required to be handled is considerably less in weight and volume. It may be feasible to screen and bag the finished compost so as to integrate the sizing of the product with its preparation for use as a soil conditioner. The larger twigs and other oversized refuse components can either be returned for seeding a new pile or otherwise disposed of. The VAM composting organization in the Netherlands has been able to develop a rasper screen which is reported to operate economically in screening and reducing the particle size of the material that has been thoroughly composted. Mechanization of compost operations is justifiable when savings in material handling can be demonstrated. Perhaps for that reason mining and lumber equipment may prove feasible for adaptation within future composting plants.

Although the San Diego tests sought an aerobic environment, it may be desirable to employ anaerobic processes for initial organic material breakdown. Valuable methane fuel gas would then be produced which could be converted to energy for producing power to operate the plant. Garbage is today often digested without difficulty in sewage sludge tanks. Anaerobic digestion followed by aerobic composting requires additional investigation.

The San Diego operations needed as much as 30-90 days of composting to complete stabilization of the garbage. The time period is much longer than laboratory composting under ideal conditions might require. Field work utilizing minimum materials handling and simplified operating controls would require the longer operating periods. However, process improvements may be developed in the future to reduce this practical operating time.

The breeding of flies during the initial stages of composting was caused by the high moisture content of the fresh San Diego garbage. This overall moisture problem might be reduced by predrying in the open air for a short time or by mixing the fresh refuse with dried reject material from the old composts. Fresh baggasse is often air dried prior to the sugar cane residue being burned as a fuel. Other operating problems such as rodents, flying papers or fires must be anticipated and prevented by good engineering and operating practice. The ultimate compost product remains to be disposed of. Since humus is a fine soil conditioner it is always anticipated that there will be a strong market demand for the compost. This has not proven to be the case for many sewage sludges. The costs of transporting a low value bulky material like compost limits the purchase area. These economic truths reduce the practical operation of a composting plant to an area where there is exists a local market. The cooperation of agriculturists and fertilizer distributors is often needed to develop and serve such a market. Compost can also serve the special purpose of supplying enough heat through continued thermophillic activity in the soil so that crops can be grown in otherwise unheated greenhouses during cold seasons. The requirement of considerable land area for a composting plant is a limiting factor. It was estimated conservatively that 25 acres are needed to serve a 50 ton/day capacity plant at San Diego.

CONCLUSIONS

1) The San Diego municipal garbage required several days of drainage to reduce the moisture content so that aerobic composting could take place. Fly breeding took place during this drainage period but subsequent composting temperatures eliminated further fly nuisance. Insecticide was employed to control fly breeding.

2) Complete stabilization of the garbage required 30 - 90 days of composting. Precutting and mixing additives with the fresh garbage did not greatly reduce the total time period.

3) The use of additives such as paper, sewage sludge, kelp, or straw did not greatly effect the final nitrogen and phosphate content of the finished compost product.

4) About 1/3 of the initial weight of the fresh garbage was recovered in the finished compost.

5) Costs of $1.56 - $20.48 per ton of fresh garbage were incurred for composting. These costs do not include overhead expenses such as supervision and plant investment but do reflect the costs of grinding, cleanup, power, turning, wetting, fly control, additive materials and screening when utilized. The high costs of composting may limit the application of this refuse reduction system to areas where sound sales markets can be developed for the compost. Improved material handling and process developments may reduce composting costs.

6) It was conservatively estimated that 25 acres would be needed to operate 50 ton/day composting plant.

Credit

This research report, which is one of a series of professional contributions by the Committee on Sanitary Engineering Research,

William T. Ingram	Air Pollution
Herman R. Amberg	Stream Pollution
Vaughn Behn	Sewage
Marvin L. Granstrom	Water
E. R. Hendrickson	Public Health
Ralph Stone	Refuse
Chairman, Nelson L. Nemerow	Industrial Wastes

has been prepared by the Refuse Section.

Francis Bowerman
Ralph Stone, Chairman

JOURNAL

SANITARY ENGINEERING

Proceedings of the American Society of Civil Engineers

SED RESEARCH REPORT NO. 6

ON VARIATION OF POINT RAINFALL WITH DISTANCE

BY The Sanitary Engineering Research Committee, Water Section.

From Research Data of F. A. Huff and J. C. Neill, Research Meteorologists, Illinois State Water Survey, Urbana, Illinois.

Acknowledgment: The Sanitary Engineering Division gratefully recognizes the generosity and professional courtesy of the authors in making these research data available to the Society for review, presentation and comment by the Water Section of the Research Committee.

Synopsis: The variation of point rainfall with distance was studied, using data from a 50-gage network within a 100 square-mile area in Central Illinois. Two regression equations were derived, relating standard deviation to: (1) point rainfall and distance from the point of observation; and, (2) to point rainfall, distance, storm duration, average storm rainfall rate, and maximum storm rainfall rate. Multiple correlation coefficients were also determined between the standard deviation and several combinations of the five independent variables. Results indicate that regression system (1) above is most practical for prediction purposes, since relatively small improvement in efficiency was found with more complex combinations of independent variables.

INTRODUCTION

The variation of rainfall with distance is an important factor in hydrological and agricultural studies where analysis of precipitation effects is required.

Note: Discussion open until June 1, 1956. Paper 888 is part of the copyrighted Journal of the Sanitary Engineering Division of the American Society of Civil Engineers, Vol. 82, SA 1, February, 1956.

Due to the normal spacing of raingages, estimates of point rainfall are frequently needed for locations which may be several miles from the nearest raingage. The U.S. Weather Bureau[1] has presented some limited results for distances up to four miles, based upon data from five stations on the Little Mill Creek Basin, Ohio. Otherwise, little information on the subject is available.

As a partial solution to the problem of rainfall variability with distance, a study was undertaken, using data collected on a concentrated network of 50 raingages, which provided data for distances up to 12 miles.

Analysis Procedure

Data from a concentrated raingage network consisting of 50 gages within a 100 square-mile area in Central Illinois were used in the analysis. Four corner gages of the network were designated as comparison gages. Arcs at increments of one-mile radius were drawn around each of these gages, so that several gages were included within each increment of one mile. Data were available for gage groups up to distances of 12 miles from the comparison gages. The plan is illustrated in Figure 1 for the gage at location a in the east corner of the network. A similar plan was followed for gages at locations b, c and d.

Standard deviations based on rainfall differences between the corner gages of the network and gages located within each one-mile increment were computed. The analysis was based on raingage data for 33 storms occurring during spring, summer and fall, 1953, in which the storm areal mean rainfall varied from 0.10 inch to 1.64 inches and comparison gage amounts ranged up to 2.20 inches. These data were treated as four sets of data; that is, a set of standard deviations were computed for the various one-mile increments of distance from each of the four corner gages, giving a total of 132 storm samples upon which to base a relationship. Each storm sample consisted of 49 observations within a distance of 12 miles.

An analytical expression of the form

$$s = k P^{l} D^{m} \qquad (1)$$

was fitted to each of the four sets of data. In expression (1), s represents the standard deviation; P is the storm rainfall recorded at a comparison gage; D is distance of the midpoint of one-mile increments from the comparison gage at which P was recorded; and k, l and m are constants. It was felt that using the four corner gages as comparison standards would provide a representative sample of variations to be expected with distance, since these four gages would provide data from several locations with respect to the storm center.

Values of k, l and m are shown in Table 1 for each of the four sets of data. The error variance for data sets 1, 2, 3 and 4 were .10, .13, .14 and .16, respectively. A test for heterogeneity among these four variances was made. This test indicated the presence of heterogeneity greater than normally

1. Thunderstorm Rainfall, Hydrometeorological Report No. 5, U.S. Dept. of Commerce, Weather Bureau, 1947.

attributed to randomness. As suggested by the results of the heterogeneity test, the proper weighting factor was applied to each of the four sets of data. The four sets of data were then combined to obtain a more reliable estimate of the k, l, and m values.

Results of Analysis

When values of the constants k, l and m for the pooled data were substituted in expression (1), the resulting equation became:

$$\hat{s} = 0.14\ P^{.77}\ D^{.39} \qquad (2)$$

where $\hat{s}$ is the "best" estimate of the standard error in inches, P is the comparison gage rainfall in inches and D is the distance from this gage in statute miles.

An analysis of variance was made in order to obtain evidence concerning the stability of the l and m values among the different sets of data. Results indicated that l and m values were stable for the four sets of data used, a result to be expected normally since the four sets were different groupings of the same data. A multiple correlation coefficient of 0.65 was obtained for equation (2).

It was felt that a more efficient equation might be obtained if some other independent variables were substituted into expression (1) in addition to P and D. However, the only practical variables which can be used in such an expression are those which can be read from a raingage chart. It was reasoned that consideration of storm duration, mean rate of rainfall, and maximum rate of rainfall might improve the prediction efficiency of expression (1). The maximum 5-minute rainfall rate for each storm was used to represent maximum rainfall rate. With these new variables added to expression (1), it took on the following form:

$$s = k\ P^{l}\ D^{m}\ R_5^{n}\ T^{o}\ R_a^{p} \qquad (3)$$

where R_s is the maximum rainfall rate, T is the duration of storm, and R_a is the average rainfall rate during the entire storm. The magnitudes of the constants, k, l, m, n, o and p were determined by the least squares method of curve fitting. When these values were substituted into expression (3), the resulting equation was:

$$\hat{s} = .27\ P^{-1.26}\ D^{.39}\ R_5^{.27}\ T^{1.72}\ R_a^{1.86} \qquad (4)$$

where $\hat{s}$ and P are in inches, D is in statute miles, T is in minutes, and R_s and R_a are in in/hr.

The multiple correlation coefficient obtained for equation (4)[2] was 0.72. This represents an increase of 10 percent in efficiency over equation (2).

---

2. Derivation of the complex regression system in expression (4) was accomplished through the use of the electronic digital computer (ILLIAC) at the University of Illinois.

Multiple correlation coefficients, involving combinations of R_s, T and R_a with the three original variables, were also computed in order to determine which of the three additional variables or combinations of these variables accounted for the greater part of the increase in the multiple correlation coefficient. These coefficients are shown in Table 2. The R^2 values are also shown in Table 2. The R^2 values (expressed in percent) indicate the relative efficiency of the various combinations of independent variables. It is apparent that the three additional variables were about equal in efficiency.

It will be noted that the partial regression of standard deviation on P changed from 0.77 in equation (2) to -1.26 in equation (4). The numerical change in this regression coefficient is due to the fact that P is correlated with R_s, T and R_a. At first the minus sign for this partial regression coefficient seemed erroneous. However, the sign of a partial regression coefficient must agree with the corresponding partial correlation coefficient. The fourth order partial correlation between s and P was -.39.

Since the product of R_a and T is equivalent to P, their use as variables in an expression already containing P appeared doubtful. However, to more thoroughly explore the problem, tests involving these two variables in conjunction with P were made. It is evident from Table 2 that including R_a and T with P increased the efficiency by only eight percent over equation (2). It is also noted (last line of Table 2) that the same efficiency was obtained by using R_a and T without P.

Considering the relatively small improvement in efficiency shown by the more complex expressions and the additional work involved in getting data to use with them, expression (2) appears more practical for prediction purposes. A graph derived from expression (2) for predicting the standard deviation is shown in Figure 2. Figure 3 shows 95 percent confidence bands based on expression (2).

The great variability in shower-type rainfall is well illustrated by Figure 3. For example, within a distance of 1.5 miles about a gage recording a rainfall of one inch, differences up to 0.33 inch or 33 percent are found between the 95 percent limits; at five miles, differences up to 0.53 inch occur; and at 12 miles, differences reach 0.74 inch.

Undoubtedly there are other factors which would be useful in increasing the efficiency of equation (2). Perhaps the most important would be a means of determining the storm path with reference to the location of the measurement gage. However, this is impossible to estimate from a single gage. Only factors which could be obtained from a single recording gage were studied in this analysis.

Discussion
(Added to original paper by the Water Section of the Research Committee of SED)

This paper should prove to be of value to the engineering profession and cognizance of its implications should be incorporated in the thinking of engineers responsible for design of works in which consideration of rainfall data is included.

There is one remark that the committee might make. That is that the correlation shown using the form of equation (1) is quite poor. Perhaps using a different form of equation rather than extending the number of variables, as suggested by equation (3), would give a better correlation value.

Engineering Implications

The present techniques of estimating areal rainfall from data taken at widely scattered stations has been shown in this paper to give quite crude estimates. The most desirable thing would be to increase the number of rainfall measuring stations; however, there is considerable cost involved in so doing. Even though the engineer is not normally supplied with sufficient data to make an accurate estimate of the total areal rainfall, he is frequently required to arrive at some value and the results of this paper clearly indicate that the value arrived at may be in considerable error. The actual total areal rainfall could be much more or much less than his best estimate determined from rainfall data taken at one or a few stations. In fact, the engineer is normally not able to make a reasonably accurate estimate of the range of values expected.

If the type of studies indicated in this paper could be conducted over larger areas in several different climatological regions and the data gathered be analyzed to give variance in areal distribution, the engineer could then give a fairly accurate range of values of total areal rainfall from the readings taken at a single station.

Credit: This research report, which is one of a series of professional contributions by the Committee on Sanitary Engineering Research,

William T. Ingram	Air Pollution
Herman R. Amberg	Stream Pollution
Vaughn Behn	Sewage
Marvin L. Granstrom	Water
E. R. Hendrickson	Public Health
Ralph Stone	Refuse
Nelson L. Nemerow, Chairman	Industrial Wastes

has been prepared by the Water Section;

Marvin L. Granstrom, Chairman

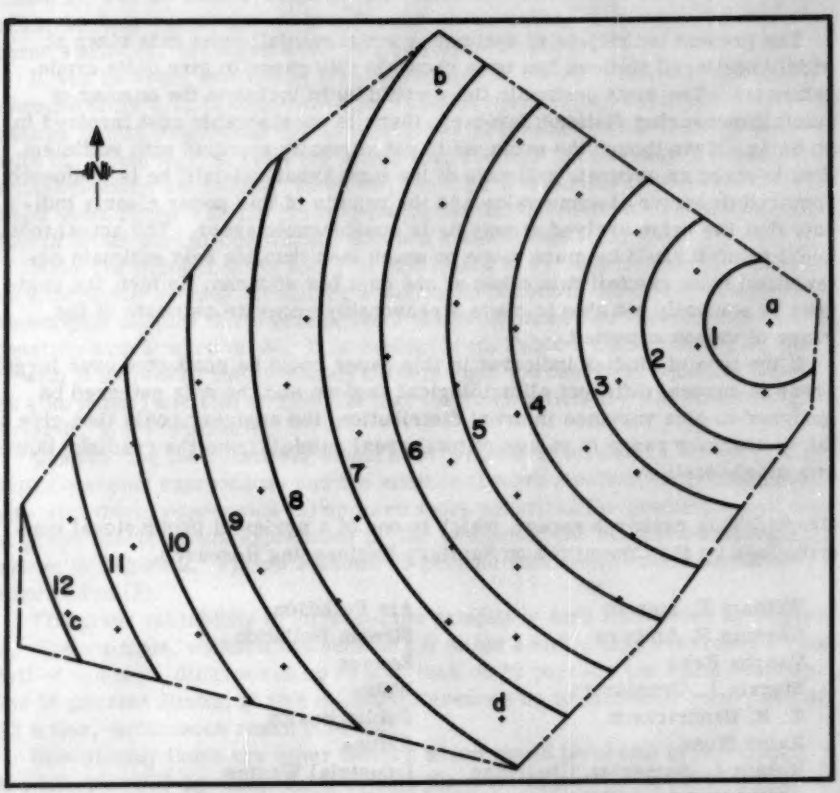


FIG. / SAMPLING PLAN ON RAINGAGE NETWORK

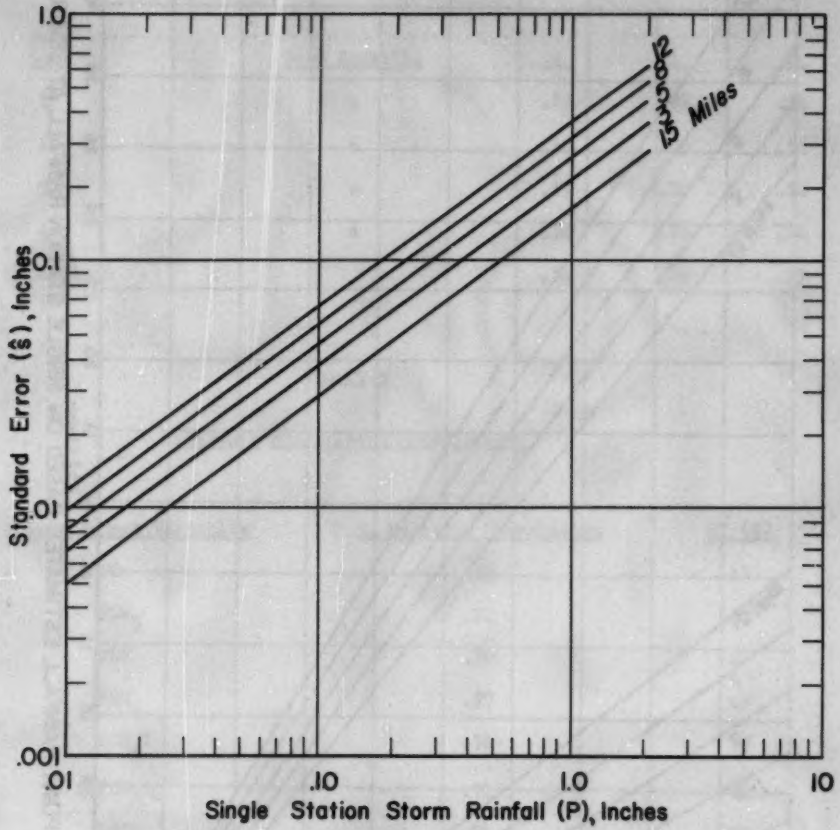


FIG. 2 VARIATION OF $\hat{s}$ WITH P

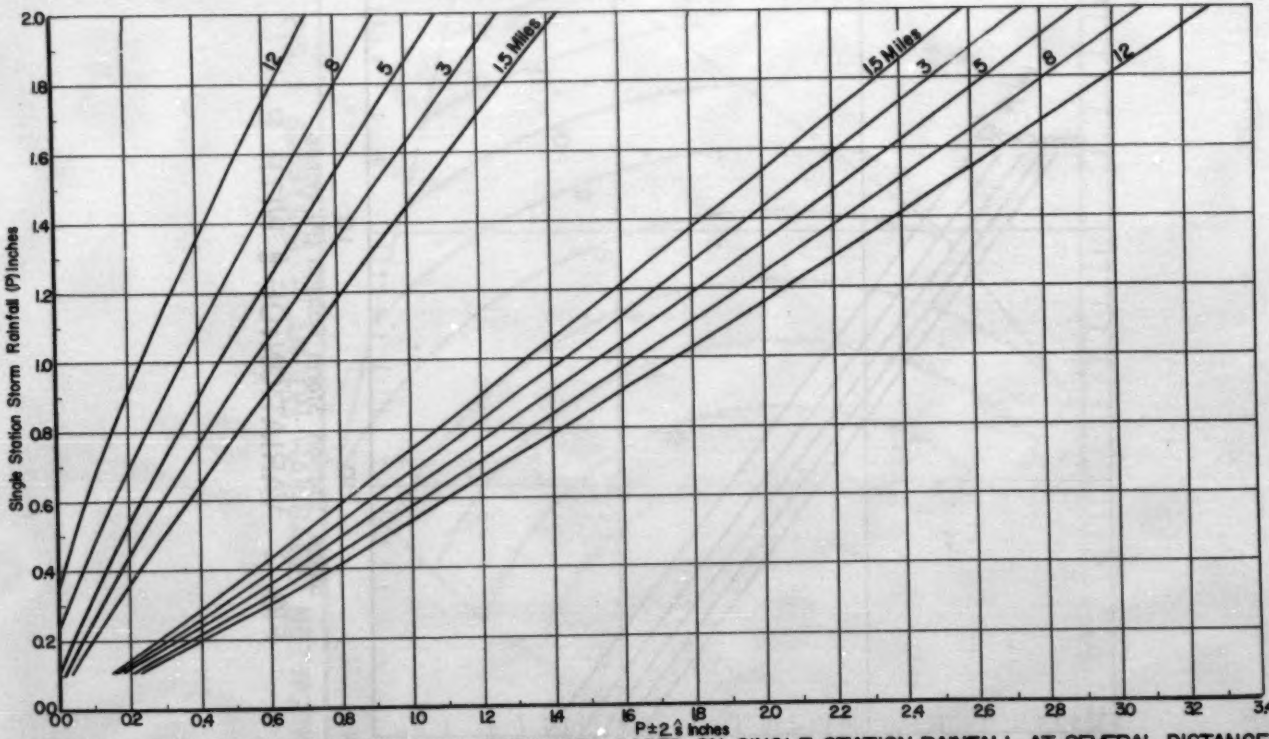


FIG. 3 CONFIDENCE BANDS FOR POINT RAINFALL ESTIMATES BASED ON SINGLE STATION RAINFALL AT SEVERAL DISTANCES

TABLE 1

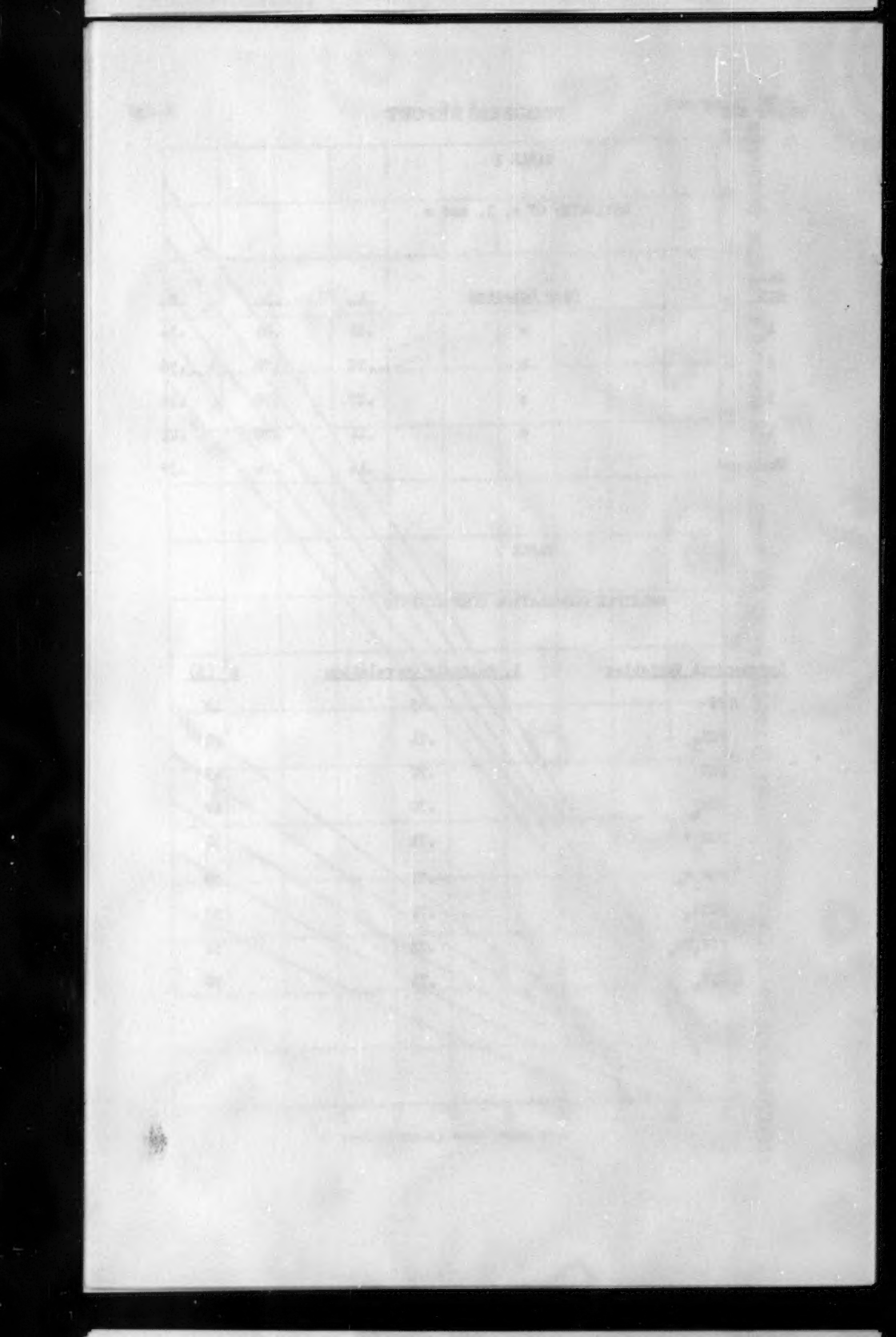
ESTIMATES OF k, l, and m

Data Set	Gage Location	k	l	m
1	a	.16	.81	.34
2	b	.10	.78	.56
3	c	.17	.76	.26
4	d	.14	.70	.41
Combined		.14	.76	.39

TABLE 2

MULTIPLE CORRELATION COEFFICIENTS

Independent Variables	R, Multiple Correlation	R^2 (%)
PD	.65	42
PDR_5	.71	50
PDT	.70	49
PDR_a	.70	49
PDR_5T	.71	50
PDR_5R_a	.71	50
$PDTR_a$	.71	50
PDR_5TR_a	.72	52
DTR_a	.71	50



Paper 889 SA 1

JOURNAL

SANITARY ENGINEERING

Proceedings of the American Society of Civil Engineers

EFFECT OF AIR CONDITIONING ON DISTRIBUTION AND PUMPING STATIONS

C. Kelsey Mathews,[1] M. ASCE
(Proc. Paper 889)

ABSTRACT

The effect of air conditioning is not generally realized and few authentic data are available. The effect of air conditioning on design of water distribution systems is different from the effect on treatment plants. The effect on distribution system design can be measured by comparison (1) of hourly demands ten years ago with present demands, (2) of ratios maximum hour to average day, and (c) of cost of improvements with and without non-conserved air conditioning. At Kansas City, Missouri, these comparisons indicate excessive investment in distribution system if non-conserved air conditioning is not prohibited.

Data of Record

Knowledge of the effect of air conditioning on water works design using a military term, and not intending a pun, is fluid. Only in the past three or four years has the water requirement of air conditioning units been recognized as being important. A great many cities are yet not impressed with its significance and very few authentic data are available. In the comparatively few cities which have observed the rapidly increasing demand for water for non-conserving units, usually something has been done about it, in the nature of "prohibiting" ordinances or of changes in rate schedules which reflect the increased cost due to the extremely poor annual load factor of such installations. Such action has affected the situation in three apparent ways:

1) To discourage to a limited extent the installation of air conditioning units, other than window units because of increased first or annual costs,

2) To force the use of water conservation equipment such as cooling towers,

3) To encourage the development and use of air-cooled instead of water-cooled units for residential or smaller commercial installations (approximately two to seven and one-half ton capacity).

Note: Discussion open until June 1, 1956. Paper 889 is part of the copyrighted Journal of the Sanitary Engineering Division of the American Society of Civil Engineers, Vol 82, SA 1, February, 1956.

1. Partner, Burns & McDonnell Eng. Co., Kansas City, Mo.

It is evident, therefore, that the experience record of water use for air conditioning is not only of short duration but also has been influenced during the period of record by the foregoing factors. Only during the past year or so have air-cooled units, except the smaller window units, been on the market. Without doubt improvements and modifications in design of air conditioning equipment in the near future will affect the proportion of total tonnage of water-cooled units installed. The economical design and planning of distribution and pumping facilities for the future will, of course, depend upon the precision with which the designer can anticipate these changing conditions.

Effect on Distribution System vs Treatment Plants

The effect of water-cooled air conditioning on the design of distribution systems is somewhat different from the effect on treatment plant design for the following reasons:

1) The capacity of distribution mains will be determined to a considerable degree by the peak hour (or perhaps fire) demand whereas the capacity of treatment plant, in a well designed system, will be determined by the average rate during the maximum day. It should be noted that while water demand for air conditioning results in a poor annual load factor, the daily load factor is good. As a contrast, uncontrolled lawn sprinkling has both a poor annual and daily load factor.

2) Treatment plant costs vary more nearly directly with capacity, while installed pipe costs do not increase in proportion to increased size and capacity.

3) Capacity in treatment plant must be provided in comparably large units, requiring initial major expenditures providing capacity for several years into the future. On the other hand, distribution mains, in a network, can be installed more or less continuously as the demand increases. Also, financing, design, and construction of treatment facilities, to relieve a shortage, require several years, whereas distribution mains require a much shorter time.

The effect of air conditioning on the design of a water distribution system will be negligible if non-conserving equipment is prohibited by ordinance. The quantity of water used by equipment including a cooling tower is in the same category as other modern household conveniences requiring water, such as automatic washing machines, dishwashers, garbage grinders, etc. However, if no prohibiting ordinance exists, even though special rates for air conditioning water are extant, it is expected that, because of convenience and lower first cost, a considerable number of non-conserving systems will be installed, and the effect on the system will be substantial.

Measures of Effect

The effect of air conditioning can best be indicated in three ways:

1) By graphical comparison showing hourly consumption on a typical summer day ten or twelve years ago (when the number of air conditioning installations was negligible) with present day records.

2) By a comparison of ratios between maximum hour and average day rates in the past, present, and anticipated future.

3) By a comparison of estimated costs for improvements to the Kansas City system for two phases, involving the cases of prohibition of non-conserving systems and the absence of such prohibition, respectively.

The importance of air conditioning to the water system has been recognized at Kansas City, Missouri for several years. Mr. M. P. Hatcher, Director of the Water Department, has not only attempted to identify and record the number and location of installations in the City, but has tried to impress and educate others in the profession as to the necessity of studying and controlling the situation. The following estimates, statements, and comparisons, therefore, are based on more authentic data than will usually be available.

Comparison of Graphs Showing Hourly Demands

The present effect of air conditioning is shown graphically by studying the hourly demands during days of maximum consumption. Figure 1 shows these data for a typical maximum day in 1942 and for days in June, August, and September, respectively, in 1953.

The 1942 graph indicates that the peak demand during the day came in the evening, obviously from lawn sprinkling. The graph for June, 1953 indicates a much more constant demand, but with lawn sprinkling still controlling the peak hour. The graphs for August and September, respectively, show the characteristic comparatively uniform demand but with the peak hour in the morning, obviously controlled by air conditioning.

Comparison of Ratios

Although many new devices using water other than air conditioning equipment, have been introduced into modern living, it appears that the ratio of maximum hour to average day has not varied substantially in Kansas City since before the time of air conditioning, as indicated by comparison of these ratios.

A study of the distribution system in Kansas City was made in 1944, in which past records of consumption were studied and used as a basis for estimating future demands. Just recently a master plan report has been completed on a similar but much more extensive basis. This latter study involved an analysis of present and anticipated future consumption by integrated small areas covering the city and contiguous rural communities. In this analysis, water use for air conditioning was considered for each of the respective areas in order to provide proper distribution facilities for serving them. From these studies the interesting ratios shown in Table 1 were determined.

Future demands in Table 1 are based on estimates of tonnage of water-cooled air conditioning equipment of which 80 per cent is estimated to be of the conserving type if the non-conserving type is not prohibited.

These tabulations indicate that with non-conserved air conditioning prohibited the maximum day and maximum hour demands in the future will probably bear about the same relation to the average day as in the past but that, with non-conserved air conditioning allowed, the ratios will be much larger. This, of course, means that distribution and transmission mains, as well as pumping stations and treatment plant facilities must be much larger without compensating increased total annual sales of water.

TABLE 1

Comparison of Ratios

	1938	1939	1940	1941	1942	1953	1960	1970	1980
Ratio Max. Day to Avg. Day	1.39	1.41	1.46	1.40	1.29	1.49*	1.80*	1.79*	1.76*
						1.28**	1.32**	1.32**	1.32**
Ratio Max.Hr.to Avg.Day	1.91	1.91	1.81	1.73	1.64	1.92*	2.72*	2.70*	2.67*
						1.60**	1.86**	1.84**	1.83**

* With non-conserved air conditioning allowed
** With non-conserved air conditioning prohibited

Comparison of Costs of Improvements

In the recently completed master plan report, two phases were analyzed, which were, in effect, as follows:

Phase 1. Improvements necessary to provide capacity up to a maximum day of 210 mgd.

Phase 2. Additional improvements necessary to provide capacity in excess of a maximum day of 210 mgd.

The maximum day demand for 1954 and the estimated demands at future dates under the respective conditions of "prohibition" and "non-prohibition" are as follows:

	1954	1960	1970	1980
Non-conserved air conditioning prohibited by ordinance (mgd)	155	192	213*	239
Non-conserved air conditioning not prohibited by ordinance(mgd)	155	254	282**	314

* Not including Missouri Water Company demand of 15 mgd
** Not including Missouri Water Company demand of 20 mgd. The Missouri Water Company is developing its own supply

These data indicate that if non-conserved air conditioning is prohibited, the improvements proposed for Phase 1 will be sufficient almost to 1970, and if all restrictions are removed, it will be necessary to commence construction on Phase 2 improvements as soon as Phase 1 is completed.

The estimated cost of the improvements for the two phases is shown in Table 2.

TABLE 2

Comparative Improvements Costs

	Distribution Improvements	Treatment Plant	Total
Phase 1	$19,847,000	None	$19,847,000
Phase 2	24,451,000	$19,911,000	44,362,000
Total	$44,298,000	$19,911,000	$64,209,000

The above costs do not include costs of six-inch and eight-inch mains for local distribution.

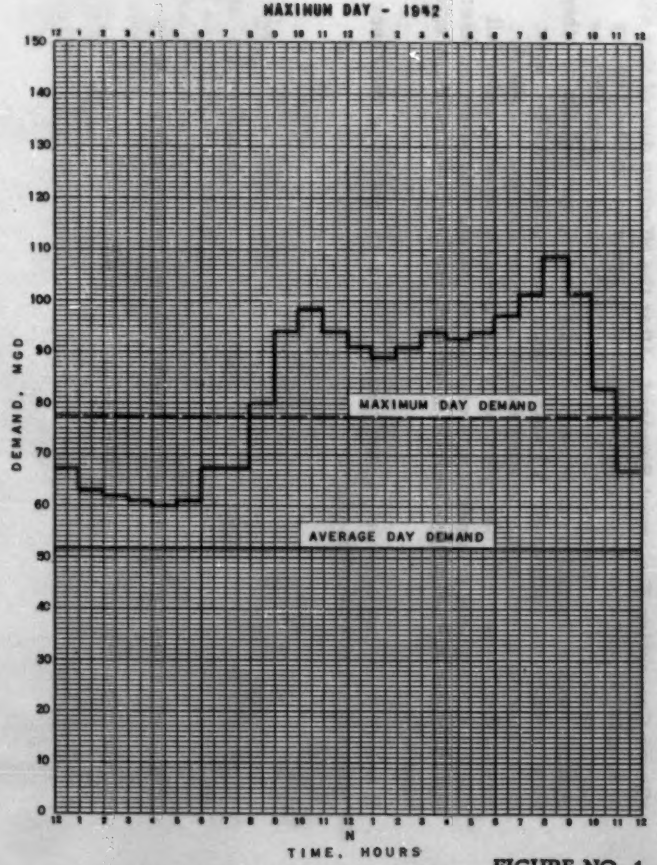
It is reasonable to conclude that, if non-conserved air conditioning is prohibited, the program of expenditure of $24,451,000 can be delayed at least ten years. The annual expense for 30-year, 3% bonds in this amount would be $1,250,000. This expense may be considered as a measure of the effect of non-conserved air conditioning on the cost of the distribution system.

CONCLUSIONS

Air conditioning installations can create demands on a water distribution system which will require excessive investments which otherwise would not be required. The situation can be controlled by an ordinance containing a clause similar to the following, now in effect at Kansas City, Missouri:

> "Water Conserving Equipment Required. After the effective date of this ordinance, all air conditioning and refrigerating systems installed on any premises served by direct connection to the City's water system shall be equipped with evaporative condensers, cooling towers, spray ponds or other water conserving equipment. All water conserving equipment shall have such capacity as will insure against the use of more than six gallons of make-up water per hour per rated ton of refrigerating capacity under full loading at maximum summer temperatures. No permit will be issued after the effective date hereof for equipment not complying with the requirements herein."

It behooves the management of every water system to determine and check the status of air conditioning.



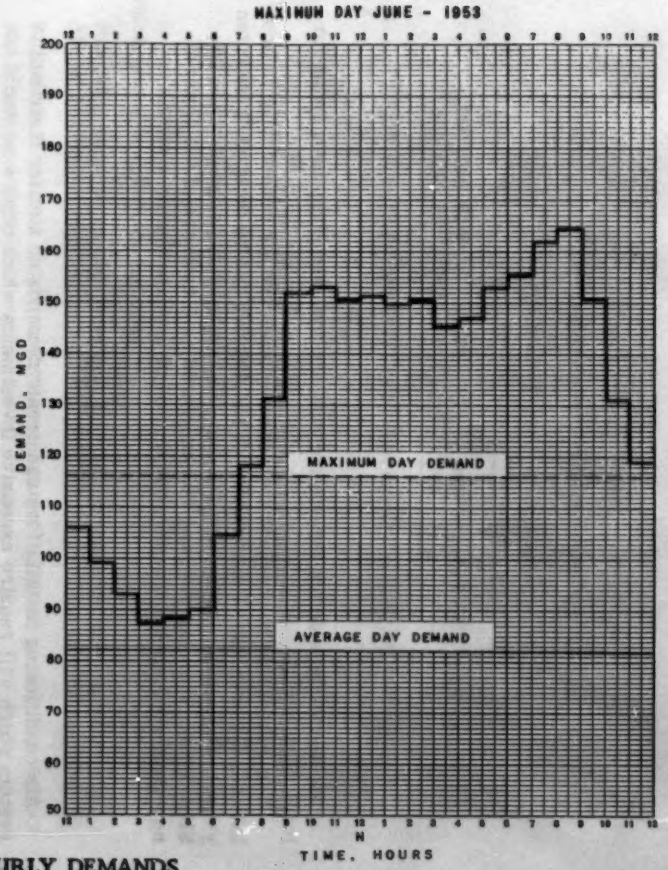
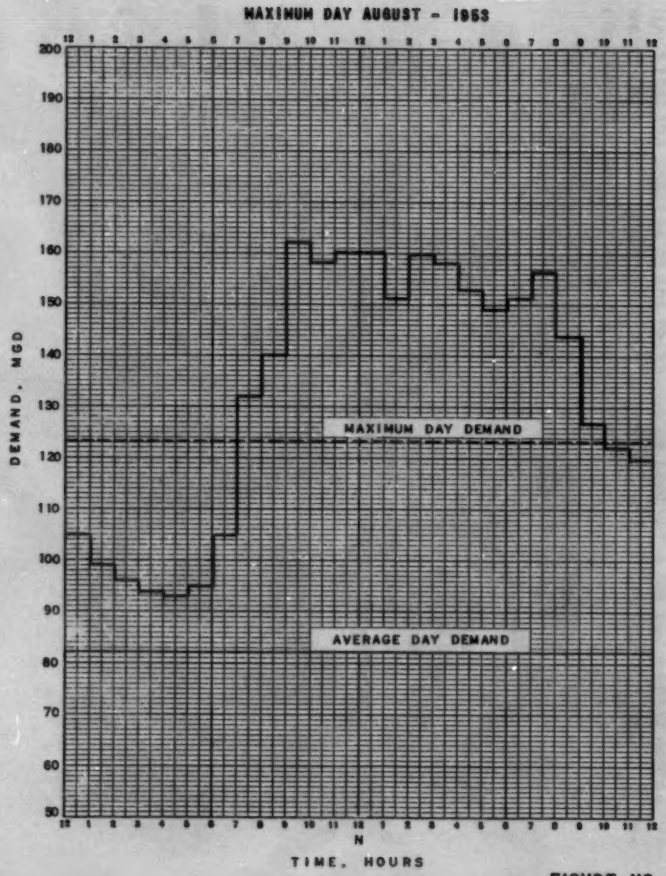


FIGURE NO. 1 HOURLY DEMANDS



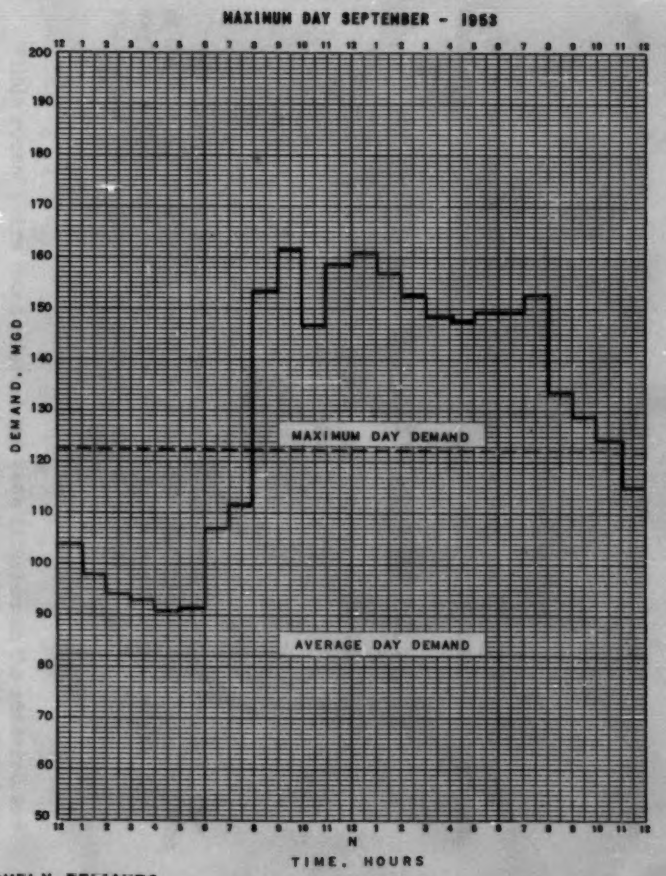


FIGURE NO. 1 HOURLY DEMANDS

Paper 890 SA 1

JOURNAL

SANITARY ENGINEERING

Proceedings of the American Society of Civil Engineers

RECOVERY OF USABLE WATER FROM SALINE WATER

David B. Smith,[1] A.M. ASCE, and Charles E. Richheimer[2]
(Proc. Paper 890)

SUMMARY

The future water demands require that all sources of water be used. One of the potential sources of water is in the vast quantities of saline water. The various methods for recovery of usable water from saline waters are discussed and the economics of each process developed.

Within recent years much interest has been centered on the research and development program to recover usable water from saline water. This interest has been largely promoted by the U. S. Department of Interior's Saline Water Conversion Program, which started in 1952. At the outset it was realized that the success of any technique or apparatus for recovering usable water from saline water must be judged entirely by how much it costs. A recent report clearly illustrates this point:

> "At the beginning of the Saline Water Conversion Program, the cost of converting sea water was estimated at about $400 to $500 an acre-foot. Accordingly, two arbitrary criteria were set for the initial 5-year phase of the program, one for water for municipal and similar purposes and one for irrigation water. For these criteria no distinction is made as to whether the water to be converted is sea or brackish water. These goals were $125 and $40 per acre-foot (38 and 12 cents per 1,000 gallons) respectively and they were believed, on the basis of data then available, to represent about the maximum that could be borne by these types of use."(1)

There are several publications(1,2,3,4) which present descriptions of the various possible methods for reclaiming fresh water from saline water, together with the theories involved. Each method can be classified as either

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(1) a proven[3] method, for which standard equipment is available, (2) an unproven method, for which standard equipment is available, or (3) an unproven method, for which standard equipment is unavailable. The first group includes various types of distillation processes, and the second, the direct ion exchange and the electrodialytic methods. The last group consists of demineralizing techniques such as solar evaporation, freezing, reverse-osmosis, and high temperature and pressure distillation. None of the last group, however, are sufficiently developed to permit a cost comparison with the methods listed in the first two.

The current status of attempts to recover usable water from saline water can best be presented by comparing the unit treatment costs of each method when applied to a saline water of given characteristics. The purpose of this paper is to present such a comparison.

Raw and Treated Water Characteristics

Let it be assumed that 2.00 m.g.d. of treated water is to be furnished from a deep well supply producing raw water of the quality indicated in Table 1. In general, the objectionable qualities of this water are defined by (1) a high dissolved solids content, (2) a high chloride content, and (3) a high total hardness content. Additionally, aeration and stabilization are needed to produce a non-aggressive stable effluent water free of objectionable tastes and odors. If the quality criteria of the treated water are to conform to the U. S. Public Health Service Drinking Water Standards of 1946, reduction of the chloride and total dissolved solids concentrations is needed, as shown in Table 2. Also, the 581 ppm total hardness should be reduced to the upper limit of 100 ppm normally accepted for municipal water supplies. Successful treatment of the raw well water to meet these standards would produce effluent water generally satisfactory for municipal consumption.

Cost Determinants

In evaluating the various processes or methods for meeting these water quality criteria it is necessary to estimate the capital outlay, the operational costs, and the total overall costs of each method based on a unit quantity of finished water produced. The estimates given in this paper represent costs per 1,000 gallons of finished water. Table 3 lists the unit prices of chemicals, labor, and power, which were used in the various estimations. Equipment costs used were manufacturer's quotations plus an estimation of delivery, erection, and housing costs, and the operational costs include an estimate for renewals and repairs required to maintain the initial equipment in operating condition for an indefinite period of time. Total capital costs are based on a 3 per cent interest charge and a 25-year amortization period which results in a gross annual charge of 5.74 per cent of the capital outlay.

Although the necessary costs for effluent stabilization and taste and odor control are included in the cost estimates, it has been assumed that standard aeration and chlorination procedures will reduce the hydrogen sulfide concentration to a non-objectionable level and that effluent stabilization is accomplished by the addition of silicate, lime, soda ash, or flue gas as the situation

3. The term "proven" is used here to designate those methods for which long-time operating data on a successful plant-scale installation are in existence.

demands. Primary considerations are thus resolved to means of reducing the chlorides, total solids, and total hardness concentrations.

Multiple Effect Evaporation

The process of vaporization applied to demineralization methods consists of evaporating a portion of the saline water after which the vapor is condensed to produce fresh water. In multiple effect evaporation the vapor from one stage is condensed in heat exchange units of the next stage where steam is being produced from brine at a temperature and pressure less than those of the previous stage. Several stages may be used, but three seems to be the normal limit. This method has been developed commercially for years, and at present almost all fresh water recovered from saline water is by one of the evaporation methods.

In order to produce a finished water of not more than 250 ppm chlorides from the raw water of Table 1, it would be necessary to produce a distillate at a rate of 1.24 m.g.d. When mixed with 0.76 m.g.d. of water which has bypassed the evaporators, the effluent water would satisfy the criteria for chlorides and total solids concentrations but would contain 221 ppm of total hardness. The bypassed water would therefore require partial softening to reduce the hardness constituents of the final product to 100 ppm. For this purpose, sodium zeolite softeners are satisfactory and have been used in determining the costs involved. Table 4 presents an estimation of the overall costs for producing 1,000 gallons of final effluent by a multiple-effect evaporation plant designed and operated at a 2 m.g.d. rate. The estimated overall cost figure is $2.45 per 1,000 gallons.

Vapor-Compression Distillation

The evaporation principle may be utilized with greater efficiency where the vapor-compression distillation process is employed. This process operates on the heat-pump principle in which the latent heat of vaporization is continuously reused. The unit first vaporizes water from saline water at atmospheric pressure after which the vapor is compressed to raise its pressure and temperature and returned to the heating side of the evaporator tubes where it condenses. In this process substantially all of the latent heat of vaporization is transferred back to the boiling brine. The fresh water condensate is then withdrawn.

In estimating the costs of treating the raw water by vapor-compression distillation units, the amount of distillate production as well as that bypassed and softened would be the same as the multiple effect evaporation process. Table 5 gives the estimated cost data for treating the raw water to meet the indicated standards of dissolved solids, chlorides, and hardness content. If diesel-driven compressors are used to compress the water vapor, and sodium zeolite units, to soften the bypassed water, the estimated overall cost of producing 1,000 gallons of finished water is $0.84 (See Table 5).

Flash Type Distillation

A third process utilizing the vaporization principle is known as flash type distillation. In flash evaporation saline water at a given temperature and pressure is released into a chamber of lower pressure where the water

vaporizes. The vapor is then condensed in cooling chambers by the incoming raw saline water to produce fresh water.

Finished water containing 250 ppm chlorides and 100 ppm total hardness could be produced from the raw water by flash evaporation equipment capable of furnishing 1.24 m.g.d. of distilled water and by partial sodium zeolite softening of 0.76 m.g.d. of the bypassed raw water. Table 6 gives an itemized list of the estimated overall costs which amount to $1.37 per 1,000 gallons of finished water.

Ion Exchange

Although the cation exchange principle has long been used in conventional water softening plants, recent developments of hydrogen cation exchangers and anion exchangers have made complete removal of dissolved salts by ion exchange a practicable method. The requirements for rinse and regeneration limit ion exchange to waters of less than about 2,500 ppm of dissolved salts,[5] but since the water selected for the present analysis contains only 1617 ppm, ion exchange may be considered here as a feasible treatment method.

A finished water containing 250 ppm of chlorides and about 630 ppm of dissolved solids may be obtained from the raw water described in Table 1 by demineralizing 1.24 m.g.d. in ion exchange units and by mixing the treated water with 0.76 m.g.d. of bypassed raw water. The total hardness of the finished water could be reduced to 100 ppm by sodium zeolite softening of 56 per cent of the bypassed water, thus producing a finished water meeting the desirable water quality criteria. Table 7 lists the estimated overall costs which amount to $0.87 per 1,000 gallons of finished water.

Electrodialysis

The most recent development in methods of recovering usable water from saline water is the electrodialysis process utilizing the properties of semi-permeable selective ion membranes.[6] In operation the process removes equivalent amounts of anions and cations from water almost without regard to the ionic constituents present. It is known, however, that ferrous, calcium, and magnesium cations tend to precipitate on the membranes thus shortening their useful life and increasing operational and maintenance costs. The water of the present example contains 192 ppm of calcium and magnesium, a concentration greater than is considered safe to apply to the membranes. Pretreatment methods to reduce the calcium and magnesium ions to minimum feasible concentrations are therefore desirable. The overall production costs will be increased accordingly, but the membrane operating life, a major factor in determining the overall costs, may then be estimated at three years.

It has also been determined that the optimum demineralization rate in the electrodialytic units is 40 per cent of the feedwater ionic concentration per treatment stage, and the optimum wastage rate is 20 per cent of the product water regardless of the number of stages employed. For the example at hand a two-stage treatment plant would be required to remove 64 per cent (40% of the original concentration plus 40% times 60% of the remaining concentration) of the original chlorides, or to produce a finished water containing 232 ppm of chlorides. In producing 2.00 m.g.d. of finished water the wastage rate would be 0.50 m.g.d. requiring a feedwater rate of 2.50 m.g.d.

There are at least two processes which may be considered for reducing the

feedwater calcium and magnesium content—sodium zeolite and lime-soda ash softening. Lime-soda ash pretreatment would reduce the hardness content to about 40 ppm and would not alter the total dissolved solids content significantly, while sodium zeolite pretreatment would reduce the hardness constituents to about zero and would increase the total dissolved solids about 5 per cent. Cost estimates show that the overall costs per unit of finished water are approximately equal for each method, so the sodium zeolite process has been selected for the example at hand because it accomplishes greater hardness removal.

A finished water containing 232 ppm of chlorides and 507 ppm of dissolved salts (as sodium chloride) may be obtained from the raw water described in Table 1 by producing 2.50 m.g.d. of sodium-zeolite softened water and by passing the entire flow through two stages of the electrodialytic units. The finished water would be quite soft but would meet the quality criteria established earlier in this paper. Total overall costs are estimated at $0.65 per 1,000 gallons of finished water as shown in Table 8. The costs are based on salt-regenerated zeolite beds, but further economies can be realized if a source of sea water or brine is available for regeneration of the zeolite units.

There are some experimental data on the use of acid pretreatment of the feedwater to render presoftening unnecessary.(7) The initial results are promising and if this technique is successful on a long-time basis the estimated overall costs per 1,000 gallons of finished water may be reduced materially by eliminating the construction, maintenance and operational costs of the sodium zeolite softening units. It would be necessary, however, to include cost estimates for the acid pretreatment and the subsequent additional pH adjustment of the effluent water, as shown in Table 9. The estimated total overall costs are $0.48 per 1,000 gallons of finished water.

Table 10 summarizes the estimated overall unit costs of the various methods considered in this paper together with the cost estimated by the Saline Water Conversion Program to be about the maximum cost that may be borne by municipalities.

CONCLUSIONS

From the cost analyses developed in this paper it is seen that the electrodialytic process for demineralizing water is at present the most economical means of recovering usable water from water of low salinity levels. While the overall unit costs of production are high, continuing research and development should improve existing methods or produce newer methods that will permit significant cost reductions. It is not yet possible, however, to recover usable water from moderately saline waters at costs competitive with conventional treatment and supply methods.

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Table 1 - Characteristics of a raw water which may be obtained from certain deep well sources

Constituent	Average concentration
Total dissolved solids, ppm	1617
Silica, ppm as SiO_2	14.3
Iron, ppm as Fe	0.14
Manganese, ppm as Mn	0
Calcium, ppm as Ca	128
Magnesium, ppm as Mg	64
Sodium and potassium, ppm as Na	287*
Bicarbonate, ppm as HCO_3	150
Carbonate, ppm as CO_3	0
Sulfate, ppm as SO_4	169
Chloride, ppm as Cl	643
Fluoride, ppm as F	0.32
Nitrate, ppm as NO_3	0.52
Carbonate hardness, ppm as $CaCO_3$	123
Non-carbonate hardness, ppm as $CaCO_3$	458
Total Hardness, ppm as $CaCO_3$	581
Carbon Dioxide, ppm as CO_2	25
pH	7.4
Color (cobalt scale)	13
Total alkalinity, ppm as $CaCO_3$	123
Hydrogen sulfide	appreciable
Temperature	23°C

*adjusted

Table 2 - Comparison of raw water Constituents with the 1946 U.S.P.H.S. Drinking Water Standards

Constituent	Raw Water	Upper limits 1946 Standards
Chlorida	643 ppm	250 ppm
Total solids	1617 ppm	500 ppm*
Taste and odor	objectionable	not objectionable

* 1,000 ppm may be permitted

Table 3 - Estimating unit costs

Item	Cost
Labor	$2.25/man-hour
Fuel oil	0.075/gal.
Electricity	0.015/Kw-hr.
Chemicals -	
Caustic soda - 50% NaOH (liquid)	0.0357/lb.
Sulfuric Acid - 66° Be	0.0167/lb.
Soda Ash	0.0215/lb.
Alum (filter alum, A.W.W.A. Spec.)	0.0283/lb.
Sodium silicate	0.0205/lb.
Lime, slaked, bagged	0.0150/lb.
Rock salt	0.0085/lb.

Table 4 - Cost estimations for the multiple-effect evaporation treatment process

Facilities costs	
Pumphouse and laboratory	$40,000
Reservoir and piping	20,000
Degasifier	15,000
Evaporators and boiler plant (1.24 m.g.d.)	2,500,000
Pumps, piping, chlorinators	70 ,000
Salt storage, transfer pumps and housing	40,000
Zeolite softeners	80,000
Brine disposal	10,000
Soft water storage	10,000
Estimated capital outlay	$2,785,000

Overall costs per 1,000 gallons of finished water	
Fuel	$2.00
Labor	0.09
Maintenance of equipment	0.09
Salt	0.03
Stabilization of effluent	0.02
Capital charges	0.22
Estimated overall costs	$2.45

Table 5 - Cost estimations for the vapor-compression distillation treatment process

Facilities costs	
Pumphouse and laboratory	$40,000
Reservoir and piping	20,000
Degasifier	15,000
Vapor-compression distillation units(1.24 mgd)	3,000,000
Pumps, piping, chlorinators	70,000
Salt storage, transfer pumps, housing	40,000
Zeolite softeners	80,000
Brine disposal	10,000
Soft water storage	10,000
Estimated capital outlay	$3,285,000

Overall costs per 1,000 gallons of finished water	
Fuel	$0.21
Labor	0.09
Maintenance of equipment	0.21
Power	0.02
Salt	0.03
Stabiliation of effluent	0.02
Capital charges	0.26
Estimated overall costs	$0.84

Table 6 - Cost estimations for the flash type distillation treatment process

Facilities costs	
Pumphouse and laboratory	$40,000
Reservoir and piping	20,000
Degasifier	15,000
Flash type boiler units (1.24 m.g.d.)	2,120,000
Pumps, piping, chlorinators	70,000
Salt storage, transfer pumps, housing	40,000
Zeolite softeners	80,000
Brine disposal	10,000
Soft water storage	10,000
Estimated capital outlay	$2,405,000

Overall costs per 1,000 gallons of finished water	
Fuel	$0.83
Labor	0.09
Maintenance of equipment	0.09
Power	0.12
Salt	0.03
Stabilization of effluent	0.02
Capital charges	0.19
Estimated overall costs	$1.37

Table 7 - Cost estimations for the ion exchange treatment process

Facilities costs	
Pumphouse and laboratory	$40,000
Reservoir and piping	20,000
Degasifier	15,000
Cation and anion demineralization units	330,000
Acid & Caustic storage and transfer piping	70,000
Pumps, piping and chlorinators	80,000
Salt storage, transfer pumps, housing	40,000
Zeolite softeners	80,000
Brine disposal	10,000
Soft water storage	10,000
Estimated capital outlay	$695,000

Overall costs per 1,000 gallons of finished water	
Sulfuric acid	$0.44
Caustic soda	0.30
Labor	0.02
Maintenance of equipment	0.02
Salt	0.02
Stabilization of effluent	0.02
Capital charges	0.05
Estimated overall costs	$0.87

Table 8 - Cost estimations for the electrodialytic process preceded by sodium zeolite softening

Facilities costs	
Pumphouse and laboratory	$40,000
Reservoir and piping	20,000
Degasifier	15,000
Electrodialytic units	720,000
Pumps, piping, chlorinators, housing, drain line, and controls	119,000
Salt storage, transfer pumps, housing	90,000
Zeolite softeners	398,000
Brine disposal	20,000
Treated water storage	50,000
Estimated capital outlay	$1,472,000
Overall costs per 1,000 gallons of finished water	
Salt	$0.15
Labor	0.06
Maintenance of equipment	0.05
Power	0.12
Membrane replacement	0.14
Stabilization of effluent	0.01
Capital charges	0.12
Estimated overall costs	$0.65

Table 9 - Cost estimations for the electrodialytic process with acid pretreatment alone

Facilities costs	
Pumphouse and laboratory	$40,000
Reservoir and piping	20,000
Degasifier	15,000
Electrodialytic units	720,000
Pumps, piping, chlorinators, housing drain line and controls	119,000
Acid storage and handling	20,000
Brine disposal	20,000
Treated water storage	50,000
Estimated capital outlay	$1,004,000
Overall costs per 1,000 gallons of finished water	
Labor	$0.06
Maintenance of equipment	0.04
Power	0.12
Membrane replacement	0.14
Sulfuric acid	0.02
Stabilization of effluent	0.02
Capital charges	0.08
Estimated overall costs	$0.48

Table 10 - Summary of cost estimations

Treatment method	Estimated overall costs per 1,000 gallons of finished water
Multiple-effect evaporation paralleled by sodium zeolite softeners	$2.45
Vapor-compression distillation paralleled by sodium zeolite softeners	0.84
Flash type distillation paralleled by sodium zeolite softeners	1.37
Ion exchange paralleled by sodium zeolite softeners	0.87
Electrodialysis preceded by sodium zeolite softeners	0.65
Electrodialysis preceded by acid treatment alone	0.48
Saline water conversion program goal for municipal consumption (1)	0.38

Paper 891 SA 1

JOURNAL

SANITARY ENGINEERING

Proceedings of the American Society of Civil Engineers

POLLUTION OF LOS ANGELES AND LONG BEACH HARBORS

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(Proc. Paper 891)

SUMMARY

As far back as 1926, the quality of the harbor waters has been noticeably impaired by discharge of sewage and industrial wastes. In the latter part of 1950, a factual survey and investigation of the disposal of sewage and industrial wastes was initiated and completed in the early part of 1952. Based upon this survey and investigation, the Los Angeles Regional Water Pollution Control Board formulated and adopted Long Range Waste Disposal and Water Quality Objectives for Los Angeles-Long Beach Harbors. These objectives and the results obtained under the objectives are described in this paper.

INTRODUCTION

The Los Angeles-Long Beach Harbor area was discovered in October, 1542, by Juan Rodriguez Cabrillo, a Portuguese. Because of the presence of smoke from brush fires started by the Indians during one of the "rabbit drives," he named the bay area Bahia de los Fumos. Sixty years later a Spaniard, Sebastian Viscaino, renamed it San Pedro Bay which became its official geographical designation. The first cargo ship, the Leila Byrd, entered San Pedro Bay in 1805, bringing spices and general cargo from Boston, and taking out hides and ores. This was strictly an illegal operation in those days, as commerce was banned with the Spanish colonists under penalty of death. In 1835, Richard Henry Dana visited the port; the stirring flogging incident as described in "Two Years Before the Mast" took place in this harbor.

General Phineas H. Banning founded Wilmington in 1850 and began development of the inner harbor area. The first railroad to the harbor, from Los Angeles to Wilmington, was completed in 1869.

After a long legal battle, the first breakwater, which was planned in the 1880's, was finally completed in 1897. This was built near the San Pedro side

Note: Discussion open until June 1, 1956. Paper 891 is part of the copyrighted Journal of the Sanitary Engineering Division of the American Society of Civil Engineers, Vol. 82, SA 1, February, 1956.

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and was eventually connected to the shore in 1912. The entire breakwater, completed in 1928, consists now of three sections: The San Pedro Breakwater, 13,350 feet; The Middle Breakwater, 18,500 feet; and the Long Beach Breakwater, 13,350 feet. Diversion of flood waters from the harbor area into the Los Angeles County Flood Control Channel was accomplished in 1923. Development of commercial fishing and fish cannery operations started in 1912. It is now a $100,000,000 industry. Discovery of oil within harbor jurisdictional areas provided a source of income, especially in the Long Beach area, which was of great financial inportance as a direct source of revenue to provide additional improvements. Approximately $135,000,000 has been invested by the Cities of Los Angeles and Long Beach in the development of the harbors.

The water area, within the outer breakwaters, is divided as follows:

Los Angeles Harbor	
Outer Harbor	981 acres
Inner Harbor	804 acres
Long Beach Harbor	
Outer Harbor	5,140 acres
Inner Harbor	210 acres

In 1949 Los Angeles Harbor handled a gross of 17,115,867 tons, while Long Beach Harbor grossed 5,598,000 tons. Shipments of petroleum and oil products make up more than 70 per cent of this tonnage. Other major commodities include fish, cotton, steel products, bananas, coffee, copra, borax, newsprint, chemicals, and many others. Almost 4,000 vessels, sailing under thirty different flags and carrying millions of dollars of commerce, enter the harbor area each year.

As far back as 1926, the quality of the harbor waters has been noticeably impaired by discharge of domestic and industrial wastes. Complaints were made of damage to buildings, equipment, harbor installations, and effect to workers in the area by sulphides emanating from harbor waters.

In 1947, public officials from the United States Government, State of California, Los Angeles County, City of Los Angeles, and certain officials of industry were invited by the district attorney's office to attend a meeting to discuss the harbor pollution problem. As a result of this meeting an advisory committee under the chairmanship of a deputy district attorney was formed to act as the committee-of-the-whole, and the following subcommittees were created, reporting to the Advisory Committee: (1) technical, (2) legal, and (3) ship. These committees were formed to establish the facts in the problem and advise in the policy for remedial measures. They were voluntary groups, unsupported by public or private funds, and without power to take official action in any capacity.

In the latter part of 1948, the technical subcommittee submitted a report to the Advisory Committee. This report contained a comprehensive study of the problem based upon several meetings of the committee members, and covered a period of more than eighteen months. The report recommended that a board of three qualified engineers be appointed to conduct necessary studies of water pollution in the greater harbor area and recommend corrective measures utilizing, wherever possible, such data and information as has already been accumulated. The report specified in detail the studies to be made; such as,

a survey of all possible sources of water pollution in the greater harbor area, including routine tests; biological studies, studies of bacterial pollution of the bathing beaches within the area, etc. It is reported that no action was taken on the recommendations contained in this report.

Subsequently, the local agencies having enforcement powers, working in cooperation with industry, launched an intensive control program over discharges into Dominguez Channel, which discharges ultimately reach the harbor waters. This program resulted in considerable improvement of the quality of the harbor waters.

Study of Pollution in the Los Angeles-Long Beach Harbors

In the latter part of 1950, shortly after the Los Angeles Regional Water Pollution Control Board was activated pursuant to the Water Pollution Control Act enacted by the 1949 Session of the California Legislature, complaints were received regarding odors and nuisance in the Los Angeles Harbor caused by the disposal of wastes.

As the result of these complaints, the Board directed the executive officer to call a meeting of the interested governmental agencies to formulate a program for an investigation of the pollution in the Los Angeles Harbor. Accordingly, in January, 1951, a meeting was held with all governmental agencies concerned with the pollution of the Los Angeles Harbor to discuss this problem. After considerable discussion, the following program was agreed upon by the representatives of the governmental agencies in attendance and submitted to the Regional Board:

1) A permanent committee of interested governmental agencies should be organized, and the scope of this committee should include both the Los Angeles and Long Beach Harbors and the Dominguez Channel.
2) That the Los Angeles Regional Water Pollution Control Board be requested to sponsor and coordinate the activities of the above Los Angeles-Long Beach Harbor Pollution Control Committee.
3) That the initial effort of this committee should be to aid and cooperate with the Regional Board in making a factual survey of the pollution of the harbor waters. To eliminate duplication of work that has already been accomplished, this survey and report, in the main, is to be the result of the accumulation of all data and information now available in the governmental agencies offices, and supplemented with the necessary laboratory work and field investigations to make the survey complete. The factual survey is to include the following:
   1) An inventory of all possible sources of pollution into the harbor waters with analyses of the discharges.
   2) Determination of the existing conditions and existing quality of the harbor waters with analyses.
   3) Determination of existing uses of the harbor waters.
4) With above survey and investigations as a basis, develop a fundamental basic policy for the control of pollution of the harbor waters by determining the conditions and quality of water to be maintained in the harbor area to protect the appropriate uses and interests involved.

At its January 11, 1951, meeting the Regional Board approved the above program and took official action to make an investigation of the disposal of sewage and industrial wastes into the harbor waters, which action was

prompted by the following four principal considerations: (1) Widespread concern over possible adverse conditions resulting from the disposal of wastes into the harbor waters, (2) need for practical basis for prescribing waste disposal requirements, (3) the Board's statutory responsibility to coordinate the actions of the various State agencies and political subdivisions within the Los Angeles Region in the control of water pollution, and (4) the Board's statutory responsibility to formulate and adopt long-range plans and policies with respect to water pollution control.

To assist the Board in making this investigation, and pursuant to the provisions of the Water Code of the State of California, the Regional Board requested the State Department of Public Health, in cooperation with all of the governmental agencies concerned, to make this factual survey and investigation and submit a report.

The management of seventeen Federal, State, and local agencies officially appointed personnel of their staffs to be members of the permanent Los Angeles-Long Beach Harbor Pollution Control Committee, and to actively participate in this investigation.

On May 15, 1952, the Regional Board received and accepted the report entitled "Los Angeles-Long Beach Harbor Pollution Survey - 1952," submitted by the State Department of Public Health. Included in this report as an appendix was a study of the biological life in harbor bottom sludges made by the State Department of Fish and Game. The Board directed that this report with the appendix be printed for wide distribution to all interested persons, industry, and governmental agencies for review and study.

During this survey and investigation, there were found approximately 235 waste discharges direct into the harbor waters. Thirty discharges were storm drains, 75 industrial, and 130 domestic or sanitary discharges. In addition to these waste discharges, 17 waste discharges into Dominguez Channel were found which ultimately reach the harbor waters. Analyses of water samples taken from the harbor waters, together with observations of physical conditions existing during the period of the investigation, showed the following:

A. The greatest degree of oxygen depletion occurred in the vicinities of Fish Harbor and at the mouth of Dominguez Channel. Samples which had the highest values for biochemical oxygen demand were found at these same places.
B. High bacterial numbers were found in the vicinities of the Los Angeles Harbor Department cannery outfall and the discharge from the Terminal Island Sewage Treatment Plant. However, bacteriological results at most of the other sampling stations were within the limits of the salt water bathing standards of the State Department of Public Health. (The present salt water bathing standards are: (1) Freedom from visible solids of sewage origin, and (2) most probable number of coliform organisms of more than 10 per milliliter should not be exceeded in more than 20 per cent of the samples taken.)
C. Floating sewage solids were not observed in the harbor waters at any time.
D. All samples collected contained small amounts of oil and grease in sufficient quantity to be determined by analyses. Visible oil and grease were observed in Consolidated Channel, Cerritos Channel, and in Fish Harbor area. Samples taken from these areas had higher oil and grease contents than those taken elsewhere.
E. Heavy metals or their salts could not be found in appreciable quantity in

the samples collected, although it was known that chromates, lead, zinc, and copper were present in waste discharges near the vicinities of several sampling stations.

F. Samples collected from the harbor waters near pipe treating operations and newly installed piling contained phenols.

Waste discharges which produced a measurable effect on the harbor waters during the period of investigation were:

A. Fish wastes depleted the dissolved oxygen content of the waters in Fish Harbor to 0.1 p.p.m. In the main harbor, waste from the fish cannery outfall created an unsightly and odorous oil and grease mat.
B. Oil well brines and refining wastes discharged into Dominguez Channel created a visible oil and grease condition in Consolidated Channel near their confluence. Similar conditions were noticed in the vicinity of the discharges from Terminal Island oil fields.
C. Discharges from the vegetable oil processing plants located along Cerritos Channel near the Los Angeles-Long Beach city boundary apparently caused an appreciable area of the channel to be covered with a white flaky material found to be high in oil and grease.
D. The effluent from the Terminal Island Sewage Treatment Plant results in measurable bacterial densities and suspended solids in the harbor waters as far as 2,000 feet or so from the "bubble." These effects are completely masked by those resulting from the fish cannery outfall during the canning season.

Waste discharges from the following were found to have no determinable effect upon harbor waters during this investigation:

A. Chemical plants.
B. Metal working shops.
C. Ship building and repair facilities.
D. Storm drains not used to convey waste effluents.
E. Toilet facilities on docks and small boats.
F. Ships docked or anchored in the harbor.

Nine main uses of harbor waters were found and were classified as follows:

A. Shipping
B. Anchorage
C. Waste Disposal
D. Recreation
E. Fishing
F. Dry Docks
G. Cooling water
H. Air washing
I. Food handling

Formulation and Adoption of Long Range Waste Disposal and Water Quality Objectives for Los Angeles-Long Beach Harbors

With the above survey and investigations as a basis, the next effort in this problem was the development of a fundamental basic policy for the control of pollution of the harbor waters.

In the development of long-range plans and policies, it is the policy of the

Los Angeles Regional Water Pollution Control Board to take two steps: (1) enunciate beneficial water uses it intends to protect, and (2) define water quality criteria to protect beneficial water uses.

In considering the first step, it is necessary to explain what is meant by beneficial water uses and why their enunciation becomes so significant in the development of these long-range plans and policies. "Pollution" is defined in the California Statutes as an impairment of the quality of water by sewage or industrial waste to a degree which adversely and unreasonably affects waters for domestic, industrial, agricultural, navigational, recreational, or other beneficial use. There is no pollution if beneficial uses of water are not adversely and unreasonably affected.

The Regional Board does not establish water uses. The Water Pollution Control Act clearly states: "No provision of this division shall be construed as affecting the right of any person to the use of water for any beneficial use other than the use for disposal of sewage and industrial wastes." Water uses are established by factors such as the California Water Plan, authorized water projects, established and planned future water uses, water rights, the economy of the area, land uses, and local and regional planning programs.

Although the regional board does not establish water uses, it does enunciate water uses it intends to protect. Prior to making this determination, the regional board considers established water uses, planned future uses, and need for economical waste disposal. The Board also recognizes that the total interest in any water pollution control program encompasses both economical waste disposal and preservation of the beneficial uses of water. To be certain that all interested parties are heard, the Board invites comments, and holds informal meetings and discussions. In this way, the Board serves as arbiter with the duty to hear all interested parties and to evaluate all factors.

After the regional board has determined what water uses it will protect, it establishes limits on physical, chemical, and bacteriological characteristics (or concentrations) beyond which the quality of the waters is impaired for beneficial uses. In determining water quality criteria, the regional board consults with agencies and individuals who are experts in particular fields of water use.

The entire process revolves around the important principle of coordinating the interests and activities of others. Each step of the over-all program is designed to take into consideration and to protect the interests of all public agencies and private organizations concerned with the related problems of waste disposal and water use.

After many informal meetings and discussions with all interested parties, including both private industry and governmental agencies, the Los Angeles Regional Water Pollution Control Board at its regular public meeting held on January 14, 1954, adopted Resolution No. 54-1 (Adopting Long Range Waste Disposal and Water Quality Objectives for Los Angeles and Long Beach Harbors).

It will be noted in the resolution that the Board enunciates the following major beneficial uses of harbor waters it intends to protect:

Outer Harbor Area

Shipping
Yacht anchorage
Bait fishing
Bathing, recreation, and sport fishing

Inner Harbor Area

Shipping
Yacht anchorage
Industrial cooling
Whole fish handling

As the name Los Angeles-Long Beach Harbors clearly implies, the primary beneficial use of harbor waters was found to be for shipping and anchorage, and therefore, it was concluded that the condition of harbor waters should permit this primary usage and be of satisfactory quality for other secondary beneficial uses as may be required while reserving a reasonable amount of the capacity of these waters for disposal of wastes from the communities and industries of the area.

To prevent pollution of the harbor waters and thereby protect the beneficial uses enunciated, the objectives are specified in three parts: (1) Water Quality Objectives Applicable to All Inner Harbor and Outer Harbor Areas, (2) Further Water Quality Objectives Applicable Only to Outer Harbor Areas, and (3) Further Water Quality Objectives Applicable Only to Inner Harbor Areas.

It is desired emphasize that it is the intent of the Board that the above objectives shall be an aim or common goal toward which to strive to prevent impairment of the quality of the harbor waters in order to protect the enunciated major beneficial uses, and that these objectives do not in themselves constitute the Board's requirements as to any specific waste disposal. Under the California Statutes, the Board's requirements for any specific waste disposal must be based upon a case-by-case determination.

Surveillance Program

Since the adoption by the Board of its Resolution No. 54-1 completed the Los Angeles-Long Beach Harbor Pollution Control Committee's initial effort, which effort was to aid and cooperate with the Regional Board in making a factual survey of the pollution of the harbor waters and to assist in the development of a fundamental basic policy for the control of pollution of the harbor waters, the Committee decided to continue actively in conducting a surveillance program. This program consists of sampling and observing the conditions of the harbor waters, and the preparation of an annual report presenting its findings of the sampling program and to record significant happenings during the year which may have affected harbor water quality.

Once each month, usually at the time of least tidal variation, conditions of the harbor waters are observed and samples taken at 17 stations in the Los Angeles Harbor area and 13 stations in the Long Beach Harbor area. Observations are made of weather conditions, water odor, color and floating matter. Transparency readings are made by lowering a 30 cm white secchi disc to a depth below water surface at which the disc becomes indiscernible. Determinations are made of temperature, dissolved oxygen and sulfide at the surface as well as at 20 foot depth.

The Committee has prepared its first annual report for the period from January 1, 1954, to December 31, 1954, which has been submitted to the Regional Board. Following is a brief summary of the findings and conclusions contained in this report:

A. Existing Harbor Water Quality with Respect to the Harbor Quality Objectives (Paragraph numbers refer to paragraphs in Resolution No. 54-1, Appendix A of this paper.)

I. Water Quality Objectives Applicable to All Inner Harbor and Outer Harbor Areas

Paragraph	Item	Findings
1	Sludge banks	Not determined in present program.
2	Grease, oil, visible solids	Found occasionally in the vicinity of fish canneries, vegetable oil plants and Dominguez Channel.
3	Dissolved sulfide	Not found except near waste discharges in inner harbor.
4	Odorous substances	Frequent in Consolidated Channel, near Terminal Island Sewage outfall and near Los Angeles Harbor Department Industrial Sewer outfall.
5	Garbage	Not found.
6	Transparency	Generally near 10 feet except in vicinity of waste outfalls.
7	Discoloration near waste outfalls	Decided discoloration near waste outfalls.
8	Temperature	West Basin shows 5 to 8° F. temperature increase over nearby water temperatures, without apparent adverse effect.

II. Further Water Quality Objectives Applicable Only to Outer Harbor Areas

1	Dissolved Oxygen	Dissolved oxygen at the surface was found below 4 p.p.m. only once in waters not adjacent to waste discharges. Dissolved oxygen was found below the specified 2 p.p.m. near waste outfalls, four times at Terminal Island sewage outfall and once at Los Angeles Harbor Department Industrial outfall.
2	Coliform density	Bathing standards met at both recreational areas - Cabrillo Beach and near Pier A, Long Beach.
3	Sludge deposits	Not determined in this program.
4	Toxic substances	No impairment to human, animal, plant, fish or bird life reported in outer harbor.

III. Further Water Quality Objectives Applicable Only to Inner Harbor Areas

Paragraph	Item	Findings
1	Dissolved oxygen	Dissolved oxygen at the surface fell below the minimum of 0.5 p.p.m. 43 times at a total of 7 stations not adjacent to waste outfalls.
2	Dissolved sulphides	Dissolved sulphides exceeded the specified 1 p.p.m. 3 times out of 12 at the station near the outlet of Dominguez Channel into the harbor waters.
3	Toxic substances	Specific tests are not made for toxic substances.

B. Conclusions

1. Adopted objectives for Harbor Water Quality are generally being met in Outer Harbor waters, although floating material, waste odors, and discoloration are found near major waste outfalls, as anticipated in the objectives.
2. Despite depression or absence of dissolved oxygen in the general vicinity of East Basin and Consolidated Channel, no impairment of a beneficial use of water has been reported.
3. Objectionable conditions have resulted from death of fish in the East Basin of Los Angeles Harbor in an area not recognized by the Objectives as of sufficient quality to maintain fish life.
4. Based upon bacteriological results, the Salt Water Bathing Standards are being met at Cabrillo Beach and in the recreational area near Long Beach Pier A.
5. Based upon the sampling program described herein, the adopted Objectives for harbor water quality are generally being met in the Inner Harbor waters except in the general vicinity of Consolidated Channel and East Basin, Los Angeles Harbor. Further investigation of the source of sulfides in Dominguez Channel seems indicated.

Pursuant to Conclusion No. 5, above, the Harbor Committee in cooperation with industry is now making a detailed investigation of this condition in the Consolidated Channel and Dominguez Channel.

CONCLUSION

After one year's operation under the adopted Objectives, the following conclusions are drawn:

1. The above objectives have fully and completely demonstrated their value as an aim or common goal toward which to strive to prevent impairment of the quality of the harbor waters for the enunciated beneficial uses, while reserving a reasonable amount of the capacity of the waters for sewage and industrial waste disposal.

2. The Objectives have been extremely helpful to the Regional Board as a guiding principle upon which Board requirements have been based for specific sewage and industrial waste discharges.

3. With complete cooperation of the governmental agencies concerned, the objectives serving as guides to these agencies have achieved coordinated action in the water pollution control program for the Los Angeles-Long Beach Harbor Areas.

4. The Objectives, in enunciating the major beneficial uses of the harbor waters the Regional Board intends to protect and establishing the water quality criteria to protect these beneficial uses, have been of great assistance to all public agencies and private organizations concerned with the related problems of waste disposal and use of harbor waters within the Los Angeles-Long Beach Harbor Areas.

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PLANNING SEWERAGE SERVICES FOR SUBURBAN AREAS

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The Problem

Much has been written during recent years concerning the problems which arise as a result of the outward mushrooming of settlements around the borders of our principal cities. These areas, which frequently remain unincorporated, have generally become known as "fringe areas" or "fringe developments." An article in the popular press (Colliers, October 11, 1952) by two consultants on municipal government refers to this outward urban development as a disease called "Suburbanitis," and a recent series of articles (The Saturday Evening Post, September, 1955) calls it "Trouble in the Suburbs." These articles include a good presentation of many of the problems confronting cities as a result of suburban growth.

There are more than 160 metropolitan areas in the United States surrounded by fringe areas or suburban developments. The Bureau of the Census estimates that thirty million persons, or nearly one fifth of the total population, live in such areas and the total is being increased at the rate of three and one-half million persons per year. Records of the Bureau of Labor Statistics reveal that in 1954, 49% of all construction, based on dollar value of building permits, was in Suburbs, with 31% in Central Cities and 20% in metropolitan areas.

It is apparent that the problems of providing sewerage, refuse collection, fire protection, police protection, and other municipal services would be greatly simplified if the city boundaries could be extended to include all fringe areas before these problems become serious. Unfortunately, this is not always practicable. The annexation of territory carries with it the obligation of providing the same municipal services that are enjoyed by the remainder of the city. To provide such services where annexations include large tracts of vacant ground between areas of development would impose a financial burden on the affected property, and on the city as a whole. Also the statutes of most states, governing the process of annexation, involve restrictions and legal procedures that limit the extension of city limits.

The general pattern of the development of suburban areas is fairly well established. During the early stages, when houses are scattered, septic tank

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systems may not create a serious nuisance and individual water supplies may be satisfactory. As the population density increases, these facilities, together with fire and police protection and other public services, become woefully insufficient. Hence, when the areas are finally annexed the city acquires a host of accumulated problems.

Many cities have found that some of the problems of suburban development can be avoided by careful advance planning, and that their best interests are served by establishing as a goal a well ordered metropolitan community. This can be accomplished where the city planning commission, acting alone or jointly with county or township planning commissions, is able to exercise zoning control over a belt extending for some distance beyond the city limits.

Sometimes natural barriers such as rivers, or political boundaries such as county or state lines intervene in such a way as to hinder or preclude either annexation or integrated long range planning. Under these conditions the suburban community usually maintains its separate identity permanently, and is frequently served by separate systems of water supply, sewers and other utilities. Communities of this type, which are often predominantly residential in character, are frequently faced with problems of expansion that are of greater relative magnitude than those of the central city.

An example of this type of development is to be found in Northeast Johnson County, Kansas, which is immediately adjacent to Kansas City, Missouri, on the east and to Kansas City, Kansas, on the north. (Figure 1) Here a fast growing and well developed urban area, comprising an extension of the Kansas City Country Club area, a dozen incorporated cities and several unincorporated areas, must solve the problem of sewers and sewage disposal through the formation of special districts. The formation of one main sewer district and the construction of main sewers and treatment works have provided the means for the complete development of one important drainage area. A second district, with privately constructed sewers and treatment facilities, serves an expanding, incorporated city. Two additional main sewer districts, comprising rapidly growing sub-divisions and two unsewered towns, have been formed and are proceeding with comprehensive plans for sewers and sewage treatment.

This change from a rural to a suburban area has occurred since 1945. The planning and development of Mission Township Main Sewer District No. 1 have involved some unusual problems and have provided experience and background which have been extremely useful in the long-range planning for the newer districts. Some important factors relating to the Mission Township sewerage program are discussed as follows:

1. Population

The rate of development in Northeast Johnson County, Kansas, during the past few years, is believed to be typical of the population growth which has been experienced in the orderly development of many suburban areas. Figure 2 shows the rate of growth of Mission and Shawnee Townships since 1946, and the summation of the two curves reflects the growth of the 76 square mile area. Figures 3 and 4 show the type of development which is taking place in Northeast Johnson County. These are views of Prarie Village in Mission Township and show the development which has taken place in 7-1/2 years. Since 1948, Prarie Village has increased from a community of approximately 1000 to a city of approximately 15,000.

2. Individual Septic Tank Systems

A few of the early subdivisions in both Mission and Shawnee Townships relied upon individual septic tanks and sub-surface irrigation to dispose of household wastes. These proved to be unsatisfactory because of unfavorable soil conditions and increasing population density. Furthermore, the widespread use of new household equipment such as garbage disposal units, automatic dishwashers, and washing machines makes the problem of disposal of liquid wastes on the premises more difficult. At the present time, individual septic tanks are used only in connection with isolated locations that are not accessible to sewers.

3. Community Sewerage Systems

Prior to 1945 and until the first main sewer district system was placed in operation in 1949, a number of subdivisions in the sewer district were served by small community type treatment plants. These plants were generally septic tanks followed by sand filters with disposal of sludge by tank truck. For the most part, these plants were well operated but even though unusual precautions were taken to avoid local nuisances, it was impossible to prevent an unsatisfactory condition in Brush Creek which crosses the State line into Kansas City, Missouri.

Johnson County Sewerage Programs

1. Metropolitan Facilities

Initial plans for providing sanitary sewers for the Brush Creek watershed portion of Mission Township area in Johnson County, Kansas, contemplated the construction of an outfall sewer to be located in the Brush Creek valley through Kansas City, and extending to a junction with an existing trunk sewer in the Blue River valley in Kansas City, Missouri, approximately four miles east of the State line. Efforts to negotiate a satisfactory agreement for discharging sewage originating in the sewer district in Kansas into the Kansas City, Missouri, trunk sewer system were unsuccessful and it was necessary to adopt an alternate plan for sewerage facilities. This plan provided for the construction of a system of main and trunk sewers to collect and deliver all sewage to a pumping station a short distance from the State line and the construction of over two miles of force mains to a treatment plant located in the Turkey Creek watershed near the Johnson-Wyandotte County line in Kansas.

2. Land Use and Density

Mission Township Main Sewer District No. 1 was organized in October, 1945. The district consists of 7,555 acres within the watershed of Brush Creek, a water-course which flows eastward across the Kansas-Missouri line into Kansas City, Missouri, and discharges into the Blue River near the eastern boundary of that City. At the time the district was formed the tributary population was approximately 11,270. To finance the initial program of main sewers, pumping station, force main and sewage treatment works to serve a population of 15,000, a bond issue of $1,300,000 was authorized by the electorate. Construction was started in April, 1947, and the system was placed in operation in 1949.

Although the conditions which brought about the demand for complete sewerage service resulted from the inability to properly handle the sewage from the built-up areas, it is of interest to note that the need for an over-all sewerage system was generally recognized when the population density for the area as a whole reached 1.5 persons per acre. The first bond issue of $1,300,000 was about the maximum which could be authorized under existing statutes governing debt limitations. This was the controlling factor in fixing the capacity of the pumping station and the treatment facilities constructed as a part of the initial program.

With the establishment of a coordinated system of sanitary sewers and sewage disposal facilities, activity in the construction of residential developments within the district was greatly accelerated. As of December, 1953, 5,241 acres or 69.4 percent of the 7,555 gross acres within the boundaries of the Main Sewer District were included in the 130 established lateral sewer districts. This left 2,314 acres or 30.6 percent of the district not included in lateral districts. Approximately 87 percent of the gross area within lateral districts, and approximately 26 percent of the area not in lateral districts has been subdivided and platted. Of the 2,396 acres of unplatted area, 664 acres or 27.7 percent were included in five golf courses within the District.

Results of a house count in December, 1953, indicated a total of 12,605 dwellings, schools, churches, and business buildings within the Main District of which 11,497 were in established lateral districts, and 1,108 were outside of such districts. In the platted areas, unoccupied building sites numbered approximately 2,900 of which 2,300 were in the lateral districts. In the unplatted areas, including the five golf courses, there were 5,400 potential building sites. In the ultimate development of the district, therefore, there may be a total of 20,900 dwellings and other buildings requiring sewer service, and the population of the district may be expected to reach 55,000 by 1960, 60,000 by 1965, and 69,500 by 1980. This is equivalent to an average density of 9.2 persons per acre with an average of 3.5 persons per dwelling.

3. Sewage Flows

It has become almost universal practice, and in some cases a requirement, on the part of builders in Johnson County to provide foundation drains for residences with basements. These drains are connected to the sanitary sewer system. This has created a problem in providing adequate sewer capacity and results in increased capital and operating costs. Actual checks made on foundation drains during periods of wet weather show flows of as much as 2,000 gallons per day per connection. On the basis of 3.5 persons per connection, this amounts to 550 gallons per capita per day during rainy periods. This is recognized as an undesirable situation but efforts to eliminate connections of foundation drains to the sanitary sewer system have not been successful.

On the basis of observed conditions in Main Sewer District No. 1, sewers in Johnson County are now being designed on basis of 3 building sites per acre with 3.5 persons per connection. Lateral and joint sewers are designed for maximum flow rates of 1,400 gallons per day per connection flowing half full. Trunk sewers are designed to carry these flows when flowing full.

4. Treatment Works

The treatment plant serving Mission Township Main Sewer District No. 1 is a conventional trickling filter plant. The effluent discharges to Turkey

Creek, a tributary of the Kansas River. Sufficient land was acquired initially to permit plant expansion as needed.

5. Additional Sewer Districts

The preceding review has indicated the type of problems encountered in planning suburban sanitary sewer systems. The Brush Creek watershed program has established a reasonable pattern for other adjacent areas, such as the Dykes Branch, drainage area, which is the next watershed south of Brush Creek. The present Dykes Branch sewerage facilities are owned by a private developer and serve the City of Leawood, Kansas. A substantial area in the lower part of the basin in Kansas formerly discharged into a treatment plant located in the Dykes Branch valley in Missouri some 800 feet east of the State line. Official orders from Missouri governmental agencies prevented the enlargement of this plant and it became necessary for the owners of the sewerage system to construct a new treatment plant at a site on Indian Creek in Kansas near the State line. Indian Creek is the next drainage basin south of Dykes Branch.

The County Commissioners of Johnson County, Kansas, have recently acquired a second site for a treatment plant on Indian Creek to serve the newly organized Indian Creek Main Sewer District.

In the long range plan for the development of the recently formed Mission Township Indian Creek Main Sewer District No. 2, it was necessary to provide temporary facilities for transporting the sewage from Indian Creek Sub-District No. 1, which is under development in the upper part of the drainage area to the site of the treatment plant. This is being accomplished by the installation of a temporary lift station and approximately 9,000 feet of 12 inch force main which is being constructed of secondhand steel pipe. It is anticipated that the temporary force main will provide sufficient capacity for a period of five to ten years at which time the development of the district will make it necessary to replace the temporary facilities with a 36 inch gravity trunk sewer.

Figure 5 shows the locations of main sewers to service Sub-District No. 1, the temporary lift station and force main to the treatment plant site. The limits of the Sub-District as presently constituted are also shown.

The treatment plant site comprises 32 acres, and is so situated as to be able to drain the entire Indian Creek basin in Kansas, totaling some 42,000 acres. The long range plan for the development of the basin will involve a second trunk sewer on the south side of Indian Creek and one or two trunk sewers paralleling Tomahawk Creek, which is the principal tributary of Indian Creek. Temporary facilities for the treatment of sewage will be utilized until the first plant unit providing primary and secondary treatment for a population of 20,000 can be designed and constructed.

By proceeding initially with the stage development of a long range plan the district has been able to acquire a treatment plant site for the entire district prior to development and to avoid the construction of a number of community type plants which have always proven to be troublesome.

Planning Considerations

1. Population

Many planners failed to recognize fully the accumulated demand for housing at the conclusion of World War II and to gage properly the rate at which

suburbs would grow. Consequently, the planning of sewerage and other services for many suburban areas was on too modest a basis. Frequently, system extensions were needed before the initially authorized facilities could be constructed and placed in service.

In the light of ten years of experience the reasons for the outward migration of urban populations are apparent. They include the lack of suitable building areas within the City, the development of traffic-ways which shorten commuting time, the initially lower taxes outside the central city and the general attractiveness of life in the suburbs. Currently there is a growing awareness of the need for better land use in the older sections of our cities and urban redevelopment programs of various types may succeed in slowing the migration of city populations to the suburbs. However, it seems certain that the normal growth of our urban areas will result in continued annexations which will be preceded by unincorporated suburban communities.

Population forecasts for suburban areas must take into consideration the factors which affect the growth of the metropolitan area. These include the relative demand for housing in the metropolitan area, the effects of Federal controls on rents, construction materials, and credit upon this demand, and the continuance of production activities which determine the rate of future development.

2. Drainage Area Concept

Joint use of trunk sewers and sewage treatment facilities by all sewer districts and other municipalities within a metropolitan area should be the objective of all long range planning when such joint use will result in the most practical and economical solution of the over-all sewerage problem. Even though political boundaries may intervene and temporary expedients have to be adopted during the developmental period it is emphasized that planning of sewer districts should be on a drainage area basis. This is not a new idea but it is certainly worthy of repetition. Main sewers should be sized and treatment plants planned to serve as large an area as possible. Where the ultimate solution is an integrated metropolitan system the capital investment in temporary treatment works must be charged off during the period of interim operation.

3. Stage Development

The planning and construction of an integrated sewerage system on a drainage area basis may involve one or more of the following.

a) The problem of providing trunk and main sewers large enough for the ultimate development when the initial development is in the lower portion of the drainage area.
b) The problem of transporting sewage to the treatment plant when initial development is in the upper portion of the drainage area.
c) The problem of expanding facilities to keep abreast of the growth of the area.

The actual facilities that can be provided in the initial program of construction are always limited by the ability of the district to finance, whether on the basis of general obligation or revenue bonds.

In the case of Mission Township Main Sewer District No. 1, the first bond issue of $1,300,000 was the maximum that could be authorized under existing statutes governing debt limitations. Under this program it was possible

to provide the essential system of main sewers, together with pumping station, force main and complete treatment facilities to serve a population of 15,000. This system was completed and placed in service in 1949.

By May, 1951, the contributing population had reached 22,000 and the pumping station, force main, and treatment plant were seriously overloaded. Special legislation was sought during the 1951 Session of the State Legislature to permit the District to issue general obligation bonds to enlarge the treatment facilities, without submitting the question to the voters for approval. As subsequently enacted, the statute authorized the district to enlarge the treatment facilities by a capacity not exceeding the capacity of the original plant, and to issue bonds to finance such expansion provided, however, that the question be submitted to the voters for approval at an election held for that purpose.

This was a serious setback in the plans for the orderly expansion of the District, since under the limitations imposed, it was not possible to provide capacity for a greatly increased load then clearly foreseeable. A special election was held in July, 1951, and $796,440 in general obligation bonds were authorized to finance the expansion program under the limitations imposed by the emergency legislation. Contracts for the construction of the expansion project were awarded early in 1952, and the major elements were completed and placed in operation in September, 1953.

During the period May, 1951, to December, 1953, the contributing population increased approximately 70 percent and the average daily sewage flow approximately 90 percent. In order to keep pace with the increasing requirements, the district is now providing plant capacity for a period of fifteen or more years in the future. To accomplish this will require the enlargement of the present pumping and treatment plant facilities to provide capacity for a population of 60,000. This is an increase of 100 percent.

A statute enacted during the 1955 Session of the State Legislature recognizes the need for the orderly development of a Main Sewer District of this type and authorizes the District to issue bonds, without a vote of the electorate, to finance the cost of extensions to sewage treatment facilities. Determination by the District of the need and estimated cost of needed extensions is on the basis of an engineering study and report, approved by the State Board of Health. The estimated cost of the extensions now being planned is $2,250,000.

Figure 6 shows the principal main sewers, pumping stations and force mains included in the three stages of development of Mission Township Main Sewer District No. 1.

4. Industries

Most suburban areas are residential in character and industrial wastes are usually not a problem in the design of suburban sewerage systems. However, the trend toward de-centralization in industry is becoming increasingly apparent and concentrated loads of industrial waste may become a factor in the design of collecting systems and treatment works.

5. Financial

Suburban areas are usually predominantly residential in character and initially the sewerage system may serve a series of widely-dispersed, built-up areas. Under these conditions, it would be extremely difficult to finance

main sewers and treatment facilities on the basis of service charges. Conversely, it is not equitable in many cases to assess the cost of long trunk sewers against undeveloped property on an ad valorem basis.

The principle of financing lateral sewers by property assessments on an area basis is well established and is equitable. Main sewers and treatment plants should be financed by revenue bonds and service charges or by a combination of revenue and general obligation bonds.

6. Legal

The rapid rate of suburban development in Northeast Johnson County, Kansas, has emphasized the need for enabling legislation which will permit greater flexibility in the organization, development of long range plans and the financing of sewer districts on a drainage area basis. In this particular location the need has been partially met through special legislation. However, there is need for a general review of the laws governing the construction and use of sewerage facilities. Such a review should take into consideration the following problems which are applicable to the planning of sewerage services for suburban areas:

a) The problem of financing the cost of preliminary planning required to determine boundaries and requirements of main sewer districts prior to the actual organization of such main sewer districts.
b) The problem of statutory debt limitations governing the authorization of general obligation bonds to finance the cost of main sewers and sewage treatment facilities.
c) Enabling legislation to permit financing in whole or in part of main sewer and sewage treatment facilities by revenue bonds and sewer service charges.
d) Recognition of the principle of the need for the orderly development of a main sewer district and legislation to permit districts to issue bonds, without a vote, to finance the cost of treatment plant and other extensions where the need for such extensions has been determined by competent authority.

7. Administration

The three main sewer districts which have been organized in Northeast Johnson County, Kansas, together with the urban township zoning boards, are all under the jurisdiction of the Board of County Commissioners. This centralized administration has the important advantage of providing integrated long range planning and management under a single operating head without duplication or overlapping of functions. Early in the development of Northeast Johnson County comprehensive sewerage program, the County Commissioners recognized the need for a competent administrative and operating staff. Following formation of the first main sewer district the Board immediately hired a professional engineer to serve as the administrative and technical head of the main sewer district. Subsequent events have indicated the wisdom of this procedure. Much of the success of the over-all sewerage program in this rapidly growing area must be credited to the Chief Engineer of the District and his staff.

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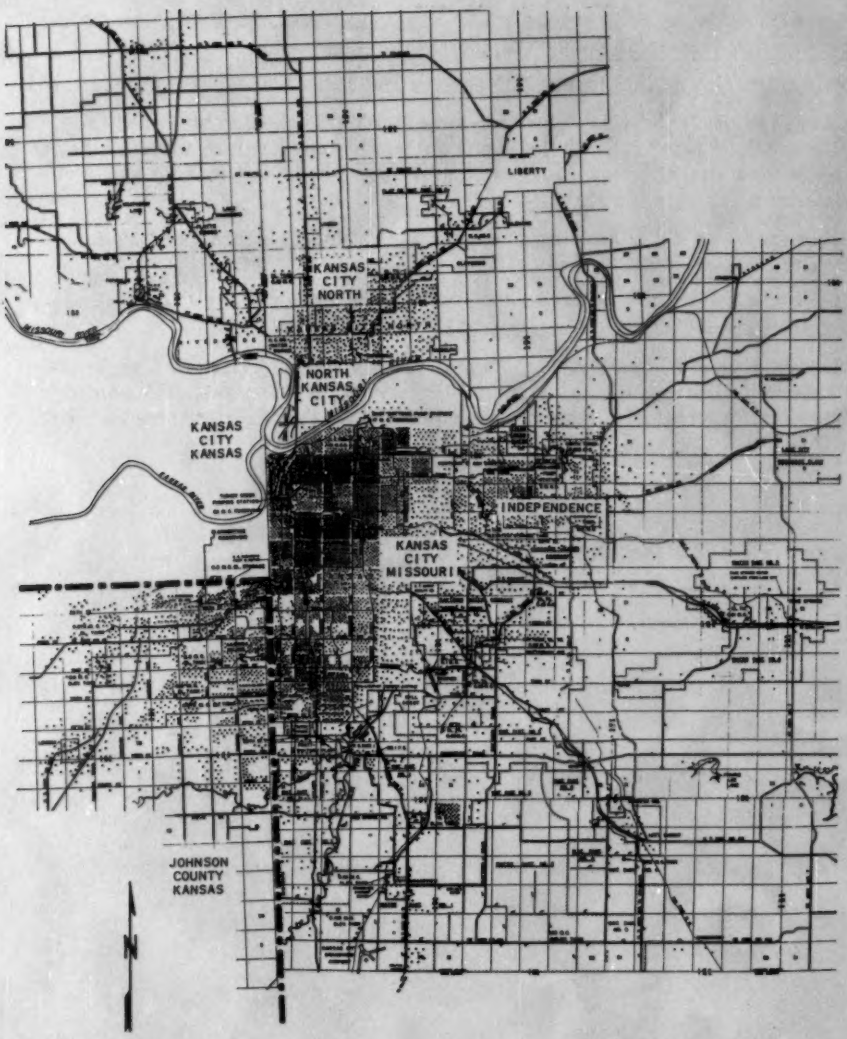
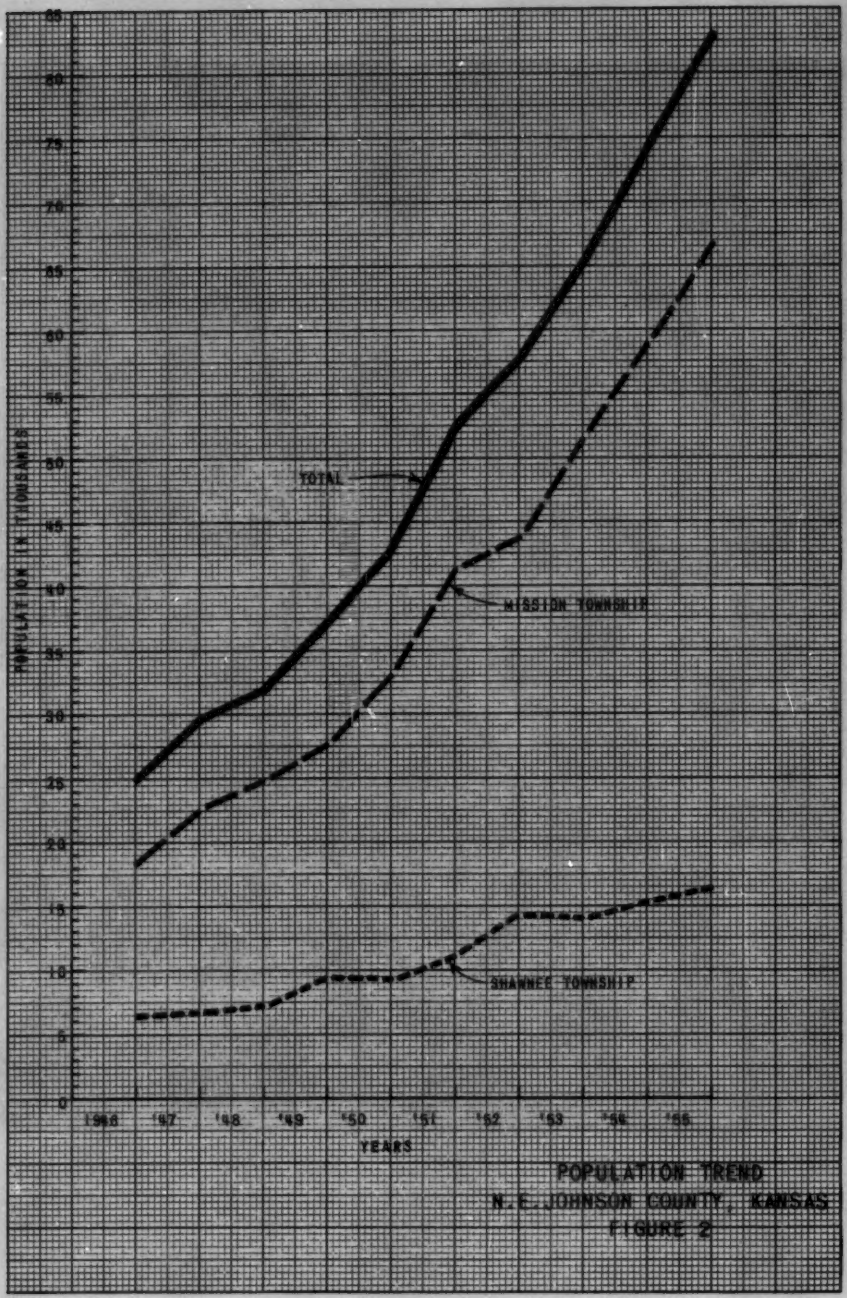


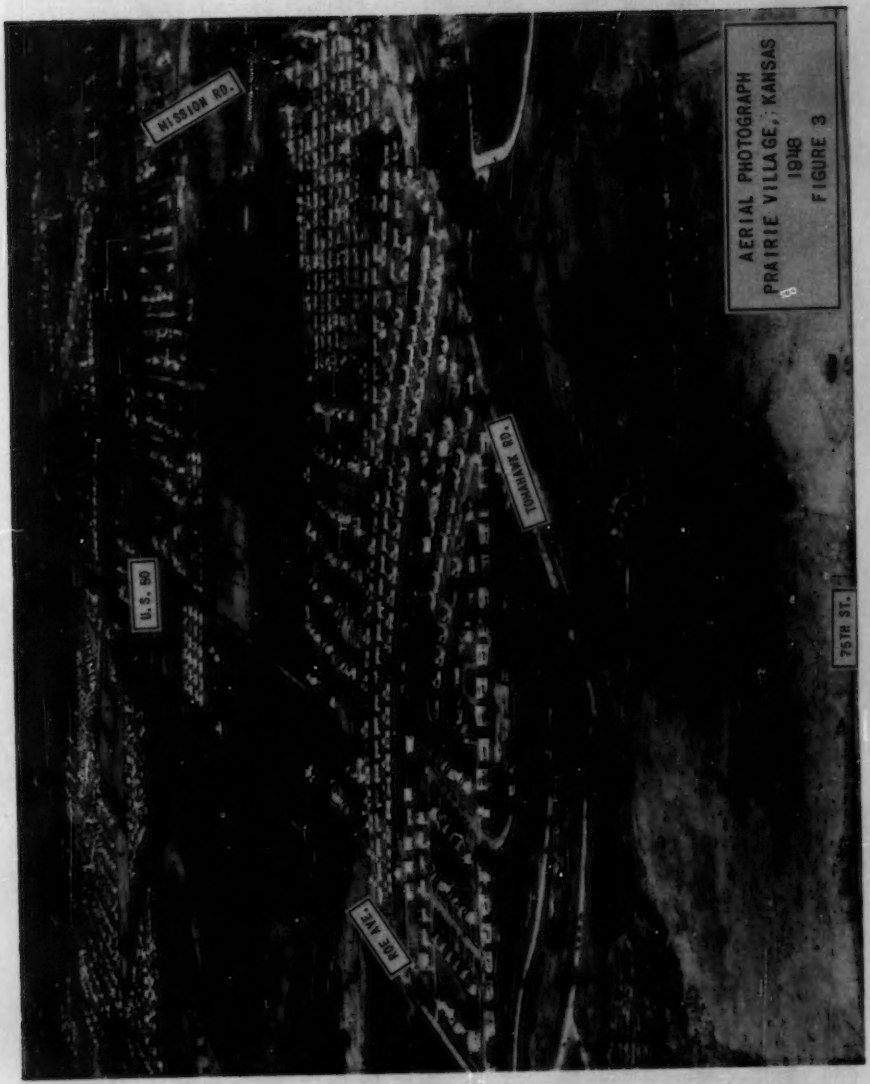
· 100 PERSONS - 1970 ESTIMATED POPULATION

POPULATION DISTRIBUTION
KANSAS CITY
METROPOLITAN AREA

FIGURE 1

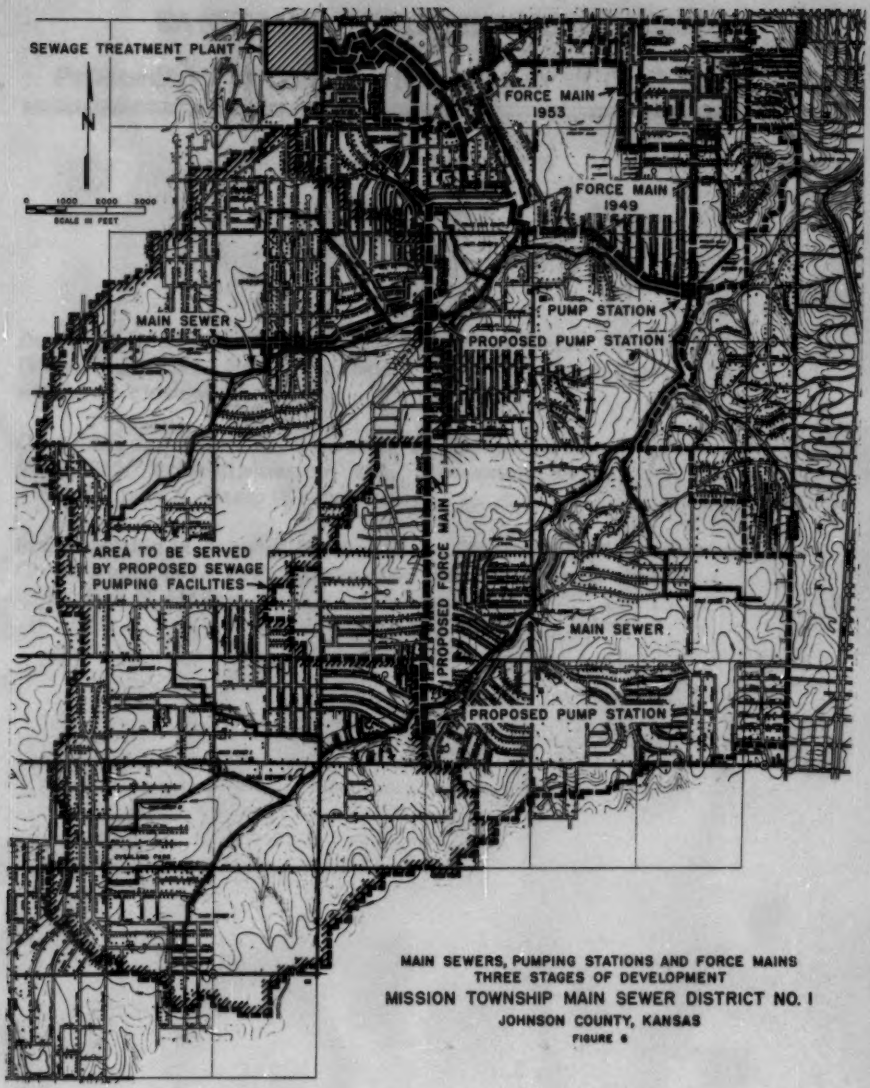


POPULATION TREND
N.E. JOHNSON COUNTY, KANSAS
FIGURE 2

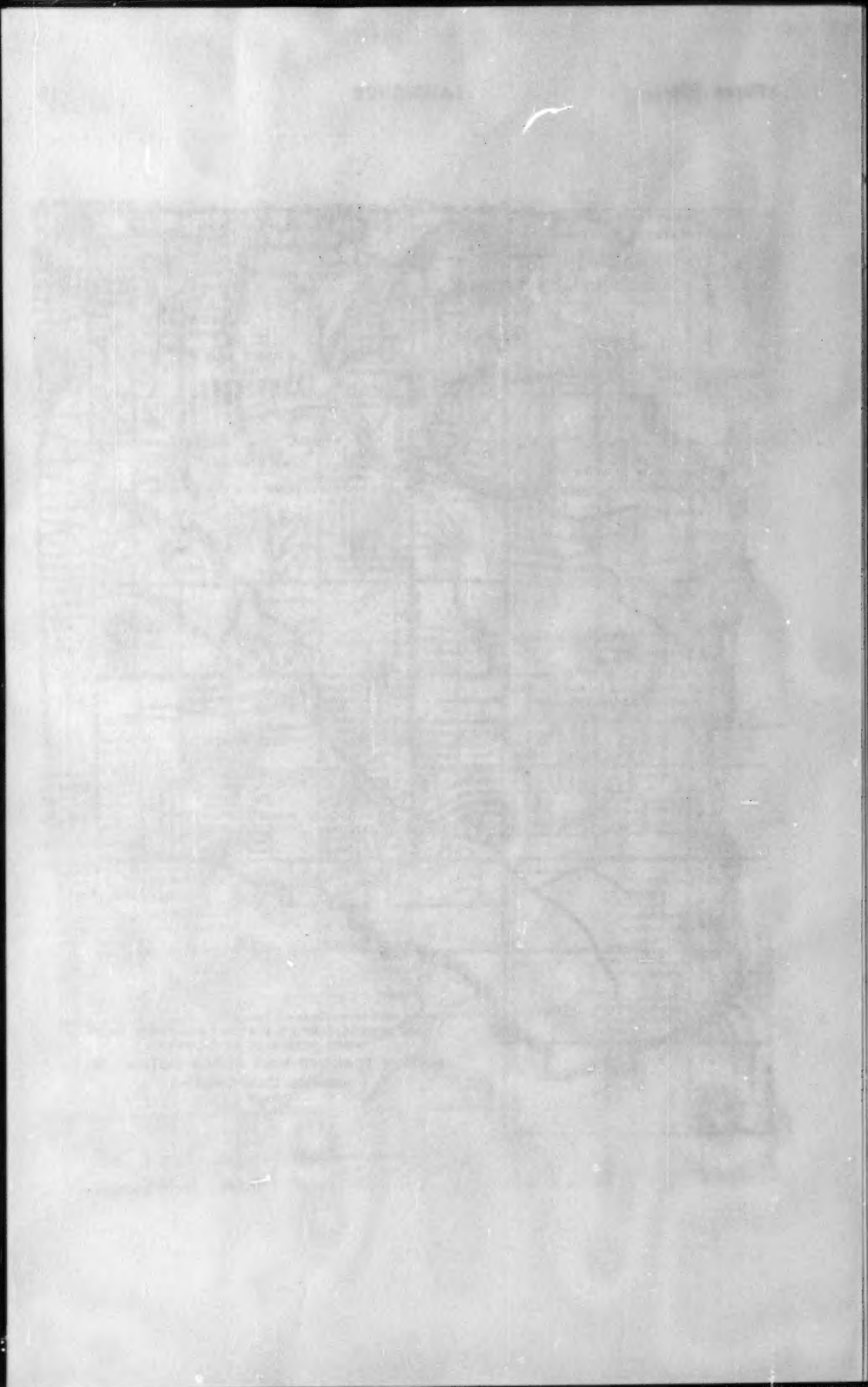

MISSION RD.
TOMAHAWK RD.
75TH ST.
U.S. 50
AERIAL PHOTOGRAPH
PRAIRIE VILLAGE, KANSAS
1948
FIGURE 3

AERIAL PHOTOGRAPH
PRAIRIE VILLAGE, KANSAS
1955
FIGURE 4
MISSION RD.
TOMAHAWK RD.
75TH ST.
ROE AVE.

INDIAN CREEK MAIN SEWER DISTRICT
JOHNSON COUNTY, KANSAS
FIGURE 8
TEMPORARY SEWAGE PUMPING STATION AND FORCE MAIN
SUB-DISTRICT BOUNDARY
MAIN SEWERS
TEMPORARY SEWAGE PUMP STATION
TEMPORARY FORCE MAIN
SEWAGE TREATMENT (PLANT SITE)
SUB-DISTRICT BOUNDARY



MAIN SEWERS, PUMPING STATIONS AND FORCE MAINS
THREE STAGES OF DEVELOPMENT
MISSION TOWNSHIP MAIN SEWER DISTRICT NO. 1
JOHNSON COUNTY, KANSAS
FIGURE 6



JOURNAL

SANITARY ENGINEERING DIVISION

Proceedings of the American Society of Civil Engineers

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Note: Paper 905 is part of the copyrighted Journal of the Sanitary Engineering Division of the American Society of Civil Engineers, Vol 82, SA 1, February, 1956.

Discussion of "CORROSION AND CORROSION RESEARCH"

by Thomas R. Camp
(Proc. Paper 685)

THOMAS R. CAMP, M. ASCE.* —The writer greatly appreciates the discussion contributed by Professor Edward W. Moore, and he regrets that the many others who evidenced an interest in the subject matter by letters were unable to find the time to prepare written discussions for publication.

Professor Moore has questioned the significance and utility of the equations developed in the section on Polarization Tests. Polarization tests are commonly used as a means of estimating the currents and potentials necessary for cathodic protection. The writer believes that laboratory tests of this type must be used as a means of verifying the theory presented, of measuring the resistance through the films, and of measuring the rates of corrosion. The purpose of the equations is to regulate the laboratory tests so that they may not be misinterpreted.

The equations developed in the section on Polarization Tests are all based on the assumption that the electromotive force at the anode and the electromotive force at the cathode are completely independent of the rate of current flow. The writer has made the statement in the paper that this is so, despite opinions expressed to the contrary in current literature. No experimental confirmation of this statement has been presented by the writer, but such confirmation may be obtained by means of carefully conducted laboratory tests such as described in the section on Polarization Tests.

The writer's statement that the electromotive force at the anode and the electromotive force at the cathode are completely independent of the rate of current flow was based on the form of equations (2), (3), and (4) which are derived from thermodynamic principles and which include no term for rate of current flow. It was further based on the fact that the physical nature of the interfacial reactions which determine the electromotive forces is not affected by the rate of current flow.

Consider, for example, an iron anode in contact with an electrolyte of constant composition. Metallic iron enters solution as ferrous ions, but ferrous ions likewise condense on the metal. At equilibrium, i.e., no current flow, the rate of solution is equal to the rate of condensation. In order to induce current flow, it is necessary that the electromotive force at the cathode be such that there is a total electromotive force for the cell which will produce a greater rate of solution of the metallic iron than the rate of condensation of ferrous ions. If the electromotive force at the cathode exactly counteracts the electromotive force at the anode, the rate of solution of metallic iron will be exactly equal to the rate of condensation of ferrous ions. Now, from equation (3) the electromotive force at the anode depends upon the concentration of the ferrous ions at the anode. If they are being produced faster than they condense on the metal, which is the case with the current

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flowing, it will be necessary to replace the electrolyte continuously in order to keep the concentration of ferrous ions constant, a condition for a constant electromotive force. This condition is easily met in most water lines with flowing water because the rate of corrosion is extremely slow as compared to the rate of movement of the water.

It will be noted from the above discussion that if the concentration of ferrous ions is maintained constant at the anode during current flow, there is no change in the physical picture at the anode because of the flow of electric current. There is no reason, therefore, to suppose that the electromotive force should change because of current flow.

Actually, in most polarization tests there is a change in the measured potentials with increase in current flow, even after compensating for the potential drop through the electrolyte. It is the writer's contention that this change in potential includes the resistance through the films on the electrodes.

Professor Moore quite rightly objects to the writer's term "plate out" when applied to electrochemical decomposition of materials like hydrogen ion, bicarbonate ion, normal carbonate ion, and the like. The term was used in order to distinguish clearly between interfacial reactions requiring the transfer of electrons at a solid boundary and ordinary chemical reactions taking place within the body of the electrolyte and having nothing to do with the corrosion cell. For example, in the writer's reaction 1, normal carbonate is said to be "plated out" at the anode. The reaction involves the combination of ionic carbonate with metallic iron at the interface. This is not plating out in the sense that a metal plate is formed, but a more descriptive term than plating out is difficult to find.

Discussion of "SEDIMENTATION IN RECTANGULAR BASINS"

by Claes N. H. Fischerström
(Proc. Paper 687)

JACK E. McKEE,* M. ASCE.—Many practicing engineers, who have designed adequate settling basins by rules of thumb based on experience, consider plain sedimentation to be a straightforward simple phenomenon. To the theoretician who tries to explain and generalize the process, however, sedimentation becomes exceedingly complex. Mr. Fischerström of Sweden has attempted to summarize and clarify a few of the concepts of sedimentation theory. To the casual reader, his presentation appears to be remarkably clear and revealing. Closer study, however, leads to several doubts. Finally, a careful investigation reveals that the author arrives at sound conclusions by means of incorrect applications of the theories of fluid mechanics.

The author's experiences with cold-water sedimentation of soft "humus" waters in Scandinavia lead him to believe that elimination of disturbances is the major problem in sedimentation. He concludes, furthermore, that "Most conventional basins of any design with the same overflow rate have about the same average settling efficiencies" and that "Practically all conventional basins with the same overflow rate can acquire the same maximum settling efficiency." To achieve optimum efficiency he proposes a basin with flow patterns as undisturbed as possible and suggests that such an undisturbed condition can be approached by dividing the flow into multiple channels formed by numerous horizontal and vertical walls. He arrives at this finding by a unique and questionable application of the Reynolds number and Froude number.

In delineating the scope of his paper, the author states that sedimentation will be influenced by two types of factors; (a) those in which the sediment itself plays a part, and (b) those that are, or can be, independent of the sediment. In the first group he includes the properties of the settleable solids, viscosity of the liquid, flocculation, and bottom scour. To the second group he allocates hydraulic properties of the basin, i.e. wall effect, kinetic currents, density currents, and turbulence. His paper deals with this second group only and his conclusions are based on this group only.

By attempting to isolate these two groups, and especially by concentrating his analysis on the second group, Mr. Fischerstrom has committed a grave omission. The settling characteristics of the suspension, as described by Ingersoll, McKee, and Brooks,[1] are paramount in determining the efficiency of sedimentation. Consequently, the author's statement that "practically all conventional basins with the same overflow rate can acquire the same

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1. "Fundamental Concepts of Rectangular Settling Tanks" by Alfred C. Ingersoll, Jack E. McKee, and Norman H. Brooks, ASCE Proceedings-Separate No. 590 (January, 1955).

maximum settling efficiency" is true only for identical suspensions and equal viscosities, in the absence of turbulence and scour. The writer contends that the settling velocity distribution (or mass curve) of the particles in the suspension is a major factor in the design of any settling basin. It cannot be ignored in any theoretical consideration of sedimentation.

Another important factor in the theoretical and practical design of settling basins is bottom scouring which the author has chosen to eliminate from his analysis. Bottom scour and the resulting suspended load are functions of the properties of the sediment and of turbulence created by shearing forces along the bottom of the tank. In this case there is an interrelation between the author's first group (eliminated from his analysis) and the second group. To concentrate on one factor without an appreciation of the other is wrong.

The author's sketch (Fig. 1) depicting undisturbed natural flow, ideal flow, and the effects of density currents, each in plan and section, is excellent. His analysis in Fig. 2, however, attempting to show in a highly specialized instance that ideal flow may not give the highest sedimentation efficiency is of academic interest solely, for it is based on a sediment comprising particles of two settling velocities only. For any sediment with a natural settling velocity distribution, ideal flow will obviously produce the optimum efficiency.

Mr. Fischerström attempts to analyze the effects of multiple surface weirs. Based on ideal flow and a highly simplified sketch (Fig. 4), he concludes that "successive draw-off does not improve sedimentation." In so doing he violates one of the very definitions of ideal flow through a rectangular basin, namely, that flow lines are parallel and velocities equal. His oversimplified analysis leads to the conclusion that the efficiency of this type of basin will be the same as a rectangular basin with horizontal flow.

Actually, construction of a two-dimensional flow net will show that the flow lines in such a tank will be decidedly curved, with velocities almost vertical in the vicinities of the multiple weirs. Moreover, the flow net shows that the numerous surface draw-offs minimize horizontal velocities in the downstream part of the tank, where the particles of lowest settling velocity accumulate. The net effects are to encourage sedimentation of fine particles and to reduce scour. Multiple weirs have demonstrated their effectiveness in many applications.

The author is to be complimented for his logical analysis, illustrated by Figs. 6 and 7, showing the difference between two-story basins operated in series and in parallel. This presentation demonstrates clearly that the efficiency of a given basin can be increased by the use of trays or multiple stories, but that much of this improvement is lost if the stories are operated in series rather than in parallel.

Having discussed a few (but by no means all) of the factors governing sedimentation in an "ideal" basin, especially insofar as tank shape is involved, Mr. Fischerström turns next to factors that create hydraulic disturbances tending to prevent ideal flow. The effects of these factors, he contends, can be controlled to a large extent by keeping the Reynolds number as low as possible and by raising the Froude number.

The Reynolds number, R, a dimensionless ratio of inertia forces to viscous forces, is recognized as one of the controlling factors in turbulence, but it is not the only factor. Indeed, when R is low enough viscous forces predominate and flow becomes laminar. Such a condition would still deviate from "ideal" flow but the disturbing effects of turbulence would be eliminated.

The Reynolds number used by the author $\left(R_t = \frac{VR}{\nu}\right)$ refers to the flow through the entire basin, and is hereinafter designated as the "tank" Reynolds number. It is not to be confused with the Reynolds number for a settling particle $\left(R_p = \frac{v_o d}{\nu}\right)$ or the bed Reynolds number $\left(R_b = \frac{d\sqrt{\tau_o/e}}{\nu}\right)$ used by other writers on this subject.

For sedimentation of water or sewage, it is out of the question to attempt to approach laminar flow by keeping the tank Reynolds number below 500 or even below 2000. Indeed, the thorough treatise by Camp[2] favors the use of long, narrow, shallow basins to minimize the effects of inlet and outlet disturbances. Such tanks have high horizontal velocities and consequently high Reynolds numbers.

The numerous horizontal and vertical walls, as advocated by Mr. Fischerström, will not change the horizontal velocity but they will diminish the Reynolds number by decreasing the hydraulic radius. Carried to an extreme, the number of channels could be multiplied until a laminar condition is produced, as in flow through soil. It is unlikely, however, that this much of a decrease in R would be economical or practical. Short of a change to laminar flow, decreases of R within the turbulent range will not have much effect on sedimentation efficiency. The author acknowledges this fact when he states " there is not much difference in settling efficiency where the Reynolds numbers in the turbulent zone are not too varied, but there might be a noticeable improvement as soon as the Reynolds number is in the laminar zone." It would appear, however, that efforts to improve sedimentation by achieving laminar flow are somewhat impractical. Attempts to reduce turbulence by altering the Reynolds number must be integrated with the other factors controlling turbulence.

Mr. Fischerström turns next to the Froude number as a parameter of stability in a basin. By stability it is presumed that he means the absence of short-circuiting or longitudinal mixing, both of which tend to cause part of the fluid to reach the outlet end of the basin in a shorter time than the theoretical detention period. He implies that stability is a function of the Froude number, F. This writer contends, however, that this implication is a misuse of the fundamental concept of the Froude number.

By definition, F is the ratio of inertia forces to gravity forces. It may be considered as the ratio of the actual velocity of a surface flow to the velocity of a gravity wave. It is used to characterize the overall flow characteristics in open channels and it is particularly useful in obtaining dynamic similarity in models and prototypes; but it has no application in closed conduits. Basically it is used to describe what happens to the free surface in open-channel flow, e.g. to study super-elevation on curves or characteristics of a hydraulic jump.

As conceived originally F involved as a linear dimension the cross-sectional area divided by the free surface area. For open rectangular channels this dimension equals the depth; hence in applying F one should confine his application to an open channel and use the mean depth rather than the hydraulic radius. To attempt to use F in closed conduits formed by multiple horizontal channels is a liberty unjustified by the original concept.

2. "Sedimentation and the Design of Settling Tanks" by Thomas R. Camp, Trans. ASCE, Vol. 111 (1946) p. 895.

Other writers have attempted to show that there is a correlation between stability and the Froude number. As early as 1936, Camp,[3] recognized this correlation when he plotted F against a ratio that involved the time for first trace of a dye to appear divided by the theoretical detention period. Higher ratios, i.e. less short circuiting, occurred at higher Froude numbers.

Correlation, however, does not signify cause and effect. Thus, the height of the polio season coincides with the time when the greatest fuzz appears on peaches; but this does not mean that fuzz has any relation to polio. Both effects, however, may be related in a complex manner to the same cause, such as season or temperature.

Short-circuiting and longitudinal mixing in settling tanks can be minimized by the use of long, narrow, shallow tanks with high horizontal velocities. Such tanks will probably have high Froude numbers. They will be highly efficient at a given surface overflow rate provided that scour does not occur and provided that bed-load movement is minimized. In contrast, it is possible to design a short, wide, shallow tank with several longitudinal walls to have a comparably high Froude number; but the stability and the efficiency will be very poor. Thus, in the author's Fig. 8 both basins have the same Froude number but quite obviously the inlet and outlet disturbances will be more detrimental in the lefthand basin than in the righthand one. Hence, stability and efficiency of sedimentation are not necessarily correlated with high Froude numbers.

The influence of the Reynolds number on stability must also be considered. At high values of R, in the turbulent range, short-circuiting can be attributed largely to longitudinal mixing produced by high velocity vectors. At low Reynolds numbers, on the other hand, stability may be poor also. In laminar flow, short-circuiting is caused by the great difference in velocity distribution across the path of flow. Viscous drag near the walls will cause a wide dispersion in the detention periods of individual particles.

Finally, it is important to reiterate what others have pointed out from time to time, namely that short-circuiting per se is not necessarily deleterious to sedimentation. Eliassen[4] shows that a density current along the upper third of a tank (e.g. warm sewage entering a cold basin) can give good settling efficiencies despite the fact that much of the flow passes through the basin in one-third of the theoretical detention period. Density currents along the bottom, however, may be highly detrimental by accelerating scour and bed-load movement.

In attempting to correlate stability with Froude number, Mr. Fischerstrom has arrived at the conclusion that sedimentation is improved markedly by subdivision of the flow into multiple basins that are long, narrow and shallow. Such basins minimize the effects of inlet and outlet disturbances, they provide a high ratio of bottom area to discharge (i.e. a low surface overflow rate), and by operation in parallel they reduce the possibilities of scour. The fact that they also provide a high Froude number is incidental, however, to their effectiveness and to the theory of sedimentation.

Mr. Fischerström is to be commended for arriving at sound conclusions despite doubtful applications of the Reynolds and Froude numbers. There

3. "A Study of the Rational Design of Settling Tanks" by Thomas R. Camp, Sewage Works Journal, Vol. 8, No. 5, (1936) p. 742.
4. Discussion by Rolf Eliassen (page 950) of Camp's paper (ref. No. 3).

is no question that rectangular settling tanks should be long, narrow, and shallow to minimize the effects of inlet and outlet disturbances. They should be shallow to provide the highest possible ratio of surface area to depth; but the horizontal velocity must not be so high as to produce scour of previously settled particles. A combination of these requirements can be achieved by the use of multiple basins stacked vertically and horizontally as Mr. Fischerström suggests. For water treatment plants, such multiple basins may be practical but for sewage or waste treatment, biochemical decomposition precludes the use of covered channels. The same efficiency may be produced by a few long narrow, open, shallow basins equipped with devices to minimize scour.

DIVISION ACTIVITIES

SANITARY ENGINEERING

Proceedings of the American Society of Civil Engineers

NEWSLETTER

February, 1956

SANITARY ENGINEERING DIVISION

Purpose: to advance scientific knowledge and promote sound engineering thought and practice in the solution of problems of environmental sanitation, notably in the provision of safe, palatable, and ample public water supplies; the proper disposal of sewage, refuse, and other community wastes; the adequate drainage of urban and rural areas for proper sanitation and the control of water, soil and atmospheric pollution. It is the further aim of the division to be well informed concerning the newer engineering problems in the field of public health such as control of insect-borne diseases, the elimination of industrial health hazards, and the provision of adequate sanitation in urban, rural, and recreational areas.

1955-56 - - DIRECTORY

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Roy J. Morton (1957), chairman; Richard Hazen (1958), vice chairman; Richard R. Kennedy (1959); Ray E. Lawrence (1959); Ralph E. Fuhrman (1956); Arthur D. Caster, secretary.

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COMMITTEE ON PUBLICATIONS

Purpose: to stimulate interest in the contribution of papers in the field of sanitary engineering for publication in CIVIL ENGINEERING AND PROCEEDINGS; and to review, edit and recommend to the Executive Committee material for publication to PROCEEDINGS.

Ross E. McKinney,* chairman; John E. Kiker, Jr; John B. Nesbitt; Harvey Wilke;* Warren Kaufman; Lindon J. Murphy; Lewis A. Young; Paul W. Reed;* Jack H. Fooks; John Wold; Roy Dragone; Roy Ramseier;* William W. Aultman;* William F. Cosulich; Julian R. Fleming; Francis J. Smith; Werner N. Grune. (Arthur D. Caster). Newsletter Editor - Paul W. Reed.

*Member of the 1955-56 Committee Control Group

( ) Contact member from the division Executive Committee

Note: No. 1956-5 is part of the copyrighted Journal of the Sanitary Engineering Division of the American Society of Civil Engineers, Vol. 82, SA 1, February 1956.

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Prof. Harold B. Gotaas

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COMMITTEE ON ATMOSPHERIC POLLUTION

Purpose: to formulate a program of constructive activity and professional leadership in this field; to establish an outline and prepare for sanitary engineers guides for the engineering practice of air-pollution control; to stimulate orderly presentation of technical material for publication; and to develop one or more manuals of practice on the subject as the need arises.

William T. Ingram, chairman; Albert F. Bush; Richard E. Hatchard; Alvin E. Meyer, Jr.; R. G. McCall; August Rossano; Jess Thomas; and William S. Foster. (Richard Hazen).

COMMITTEE ON PREPARATION OF A MANUAL OF PRACTICE ON SANITARY AND STORM SEWER DESIGN AND CONSTRUCTION

(Joint Committee with the Federation of Sewage and Industrial Wastes Associations)

Purpose: to prepare a manual of practice on the design and construction of sanitary and storm sewers.

Bernal H. Swab, chairman; Richard R. Kennedy; C. Gordon Gaither (1); Joseph C. Lawler, Jr.; Ray E. Laerence; Ray R. Ribal; H. S. Smith (1); C. R. Velzy (1); L. L. Sphar (1); S. I. Zack (1); (Richard R. Kennedy).

(1) Representing FSIWA

COMMITTEE ON PREPARATION OF A MANUAL OF PRACTICE ON SEWAGE TREATMENT PLANT DESIGN

(Joint Committee with the Federation of Sewage and Industrial Wastes Associations)

Purpose: to prepare a manual of practice on the design of sewage treatment plants.

Daniel A. Okun, chairman; Norval E. Anderson (1); G. K. Erganian; T. R. Haseltine (1); L. W. Van Kleeck; (Richard R. Kennedy); H. H. Klegerman (1); George Martin (1); Edward S. Ordway; Clyde L. Palmer (1); David Caldwell.

COMMITTEE ON PUBLIC HEALTH ACTIVITIES

Purpose: to continue the study of engineering activities in the field of public health which should be undertaken by the division, recommendations to be made to the Executive Committee as the need for programs arises; and to organize and direct the activities of a task group which will develop a brochure or manual of practice covering the methods of planning, design, financing, construction, maintenance, and operation of water and sewer systems for suburban areas.

Dwight F. Metzler, chairman; Arthur N. Beck; Earl Devendorf; Emil C. Jensen; George W. Marx; W. W. Towne; (Roy J. Morton).

Membership Task Force: Arthur N. Beck; Earl Devendorf; Emil C. Jensen; George W. Marx.

Water and Sewage Systems for Suburban Areas Task Force: (to be organized)

COMMITTEE ON REVISION OF MANUAL NO. 19 - DESIGN OF WATER TREATMENT PLANTS

(Joint Committee with the American Water Works Association, Inc.)

Purpose: To revise this manual and to bring it up to date.

Ray L. Derby, chairman; W. W. Aultman (2); John J. Baffa; Charles P. Black; H. O. Hartung (2); Richard Hazen (2); H. E. Lordley (2); R. L. McNamee (2); Robert C. Marz; Guy R. Scott; H. L. Thompson; (Richard Hazen).

COMMITTEE ON INDUSTRIAL WASTE PRACTICE

Purpose: to study the varying requirements of industrial waste treatment; to indicate the functions in which sanitary engineers are qualified to practice; to prepare and stimulate such articles and manuals of practice as are pertinent to the attainment of these objectives.

William S. Wise,* chairman; John J. Baffa,* vice-chairman; John E. Kinney;* E. B. Besselievre;* Arthur D. Caster;* John Bethel; Earl Kelly; Don E. Bloodgood; Bruce Dickerson; W. W. Eckenfelder, Jr. (Ray E. Lawrence).

*Members of the 1955-56 Committee Control Group.

COMMITTEE ON SANITARY ENGINEERING RESEARCH

Purpose: to provide leadership in pointing out research needs, in generating interest and financial support for sanitary engineering research, and in discussing the relationship and utilization of specific research findings to sanitary engineering practice; and to report on the latest research developments through the use of the PROCEEDINGS outlet to the division and emphasizing the interpretation and significance of research developments.

Nelson L. Nemerow,* chairman; Vaughn Behn, Jr.;* Marvin L. Granstrom;* William T. Ingram; Jack E. McKee;* David Smith; Ralph Stone;* (Richard Hazen).

COMMITTEE ON SEWERAGE AND SEWAGE TREATMENT

Purpose: to submit sectionalized reports as follows: Section I - Sewerage; Section II - Primary Treatment; Section III - Secondary Treatment; Section IV - Sludge Disposal; Section V - Financing and Legal Aspects; and Section VI - Specialized Subjects; — one or more sectionalized reports to be submitted annually and each section to be included for reporting not less than once in five years. The reports shall emphasize sanitary engineering applications, design bases, costs, increased technical proficiency, and sound engineering practice. To avoid duplication of work, efforts shall be made to develop cooperation with other organizations serving this field.

Kerwin L. Mick, chairman; Francis R. Bowerman; Fred H. Burley; Gail P. Edwards; William F. Garber; Paul D. Haney; Langdon Pearse and William H. Torpey. (Richard R. Kennedy).

COMMITTEE ON THE SANITARY ENGINEERING ASPECTS OF NUCLEAR ENERGY

Purpose: to advance the body of knowledge involving sanitary engineering and radiological health; to stimulate interest and activity in this field by sanitary engineers; to increase the sanitary engineer's know-how in this field; to recommend committees for special task investigations and reports; and to recommend publication of manuals and papers on subjects in this field.

Conrad P. Straub; chairman; Earnest F. Gloyna, Arthur E. Gorman; Warren J. Kaufman; Alexander Rihm, Jr.; James G. Terrill, Jr.; (Roy J. Morton)

COMMITTEE ON WATER SUPPLY ENGINEERING

Purpose: to submit sectionalized reports as follows: Section I - Water Resources; Section II - Water Analyses and Testing; Section III - Design of Supply Works; Section IV - Design of Treatment Works; Section V - Distribution Systems; Section VI - Financing and Legal Aspects; Section VII - Specialized Subjects; - - one or more reports to be submitted annually and every section to be included for reporting not less than once in five years. The reports shall emphasize sanitary engineering applications, design bases, costs, increased technical proficiency, and sound engineering practice. To avoid duplication of technical services, efforts shall be made to develop cooperation with other organizations serving this field.

Robert D. Mitchell, chairman; M. P. Crabill; Karl Kennison; John D. Longwell; Thomas Niles; E. A. Pearson; Harvey F. Ludwig; E. W. Whitlock; Robert Harris; (Richard Hazen).

JOINT COMMITTEE FOR THE ADVANCEMENT OF SANITARY ENGINEERING

Purpose: to advance the training and professional status of sanitary engineers.

ASCE - Earnest Boyce; Thomas R. Camp; and W. A. Hardenbergh; AWWA, Inc. - W. R. LaDue, R. E. Stiemke, R. J. Faust; APHA - Mark Hollis, George O. Pierce, Clarence I. Sterling; ASEE - Gilbert H. Dunstan, J. E. Kiker, Jr., Rolf Eliassen; FSIWA - R. E. Lawrence, R. S. Rankin, Dwight F. Metzler; (Roy J. Morton).

AWWA - American Water Works Association, Inc.
APHA - American Public Health Association, Inc.
ASEE - American Society for Engineering Education
FSIWA - Federation of Sewage and Industrial Wastes Associations.

PREPARATION OF A MANUAL OF PRACTICE ON SANITARY LANDFILL

(Ralph E. Fuhrman,) Desso T. Mitchell, chairman; P. H. McGauhey; Jean L. Vincenz; Leo Weaver; Joseph Banta.

MANUAL OF PRACTICE ON INCINERATION OF MUNICIPAL REFUSE

(Ralph E. Fuhrman), M. H. Klegerman, chairman; F. R. Bowerman, S. M. Clarke; R. H. Ritter; C. A. Rogus.

EXECUTIVE COMMITTEE MEETS WITH TECHNICAL COMMITTEE CHAIRMEN AT NEW YORK

On Sunday, October 23, the Executive Committee of the Sanitary Engineering Division met with the Chairmen of the Technical Committees to review Committee accomplishments for the previous year and to plan the Division's professional program for the year ahead. The enthusiasm displayed by Committee Chairman for their assigned tasks and the reports of progress to date were most encouraging.

William T. Ingram reported that the COMMITTEE ON ATMOSPHERIC POLLUTION has been organized and has developed a plan for investigation and report. The Committee plans to develop a compendium of information for Sanitary Engineers that will assist them with problems that arise in air pollution control work. It is believed that two to three years will be required to conduct the necessary investigations, assemble data, and prepare its report.

Daniel A. Okun reported that the COMMITTEE ON PREPARATION OF A MANUAL OF PRACTICE ON SEWAGE TREATMENT PLANT DESIGN had sent out questionnaires requesting information on 115 sewage treatment plants located in 24 states which have been designed in recent years. It was reported that the Committee is desirous of obtaining as large a sample as possible and suggested that Consulting Engineers could obtain questionnaires from Professor Okun and assure representation of their plants in the study. As soon as the questionnaires are returned the analysis will be made and the manual prepared.

Bernie Swab reported that the work of the COMMITTEE ON PREPARATION OF A MANUAL OF PRACTICE ON SANITARY AND STORM SEWER DESIGN AND CONSTRUCTION was progressing and that a final draft should be ready for submission to the Sanitary Engineering Division and the Federation of Sewage and Industrial Wastes Association by August 30, 1956.

The PUBLIC HEALTH COMMITTEE has concentrated its efforts during the past year on a study of suburban sanitation problems according to Dwight Metzler the chairman. George Reid and Ivan Shull have completed the study of the Kansas City Metropolitan Area and the Committee is using the findings to determine how many additional areas should be studied prior to the development of a manual of practice covering the methods of planning, design, financing, construction, maintenance and operation of sewer systems.

William S. Wise reported that the COMMITTEE ON INDUSTRIAL WASTE

PRACTICE was organizing to study procedures and practices in the field of industrial waste disposal. A special attempt will be made to keep advised of the activities of other organizations in this field rendering assistance where desirable through coordination of activities.

Nelson L. Nemerow, Chairman of the COMMITTEE ON SANITARY ENGINEERING RESEARCH reported that his Committee has been organized into 7 sections which will concern themselves with research activities in the specialized fields. They are: Air Pollution, Public Health, Industrial Wastes, Refuse, Stream Pollution, Sewage, and Water. The Committee is endeavoring to bring new research in allied fields to the attention of SED members in a form that can be readily assimilated and to foresee and encourage needed research in the field of Sanitary Engineering.

The COMMITTEE ON WATER SUPPLY ENGINEERING is preparing a a series of 7 reports for Proceeding Separates starting in 1956. This series will emphasize such diverse aspects as: design of source treatment and distribution system facilities; financial and legal aspects; testing and analysis, and water resource problems. Subcommittee Chairmen have been assigned for each aspect according to Robert D. Mitchell, the Committee Chairman and Coordinator.

Earnest Boyce reported that the JOINT COMMITTEE FOR THE ADVANCEMENT OF SANITARY ENGINEERING had been active in cooperating with other societies in the organization of an inter-society board for the certification of sanitary engineers. For details on Professor Boyce's report see article on certification.

Ross McKinney, chairman of the COMMITTEE ON PUBLICATION AND Paul W. Reed, NEWSLETTER editor, discussed the plans for a Sanitary Engineering Journal starting in 1956 and the effect this development would have on publications committee activities. It was reported that while an attempt would be made to publish the Journal quarterly, the frequency of publication would be determined by the volume of papers presented for publication. Each Journal would contain about six technical papers and the NEWSLETTER which was to be included as a section entitled "Division Affairs." The fear was expressed by Reed that the lack of a regular publishing date would make it difficult to maintain the news aspects of the NEWSLETTER.

M. H. Klegerman reported that the COMMITTEE ON THE DEVELOPMENT OF A MANUAL OF PRACTICE ON MUNICIPAL INCINERATION OF REFUSE is somewhat behind the schedule set for itself. As of the time of the meeting, however, a detailed outline of the manual had been completed. The present schedule calls for the submission of the completed manual to the Executive Committee by February 1957.

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Correction to "Sanitary Engineer."

The July newsletter, pp. 6 and 7, carried the definition of Sanitary Engineer as redefined by the Committee on Sanitary Engineering and Environment of the National Academy of Sciences - National Research Council on December 14, 1954. Foot-note 2, explaining the meaning of "an institution of recognized standing" should have read:

> "An educational institution of recognized standing is defined as one which is accredited by a national or regional accrediting association

such as the Association of American Universities, or the New England, Middle States, North Central, Southern, or Northwest Association of Secondary and Higher Schools, or one whose professional curriculum has been accredited by the Engineers Council for Professional Development of the Committee on Professional Education, American Public Health Association."

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DID YOU KNOW THAT—

Industrial Wastes, a new magazine in the field, is edited by Don E. Bloodgood of Purdue, a member of SED and author of "Are Sanitary Engineers Holding Their Own. . . ." appearing in the December issue of SED Newsletter.

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MARK HOLLIS, Chief Engineer of U. S. Public Health Service recently returned from a two months review of the Sanitary Engineering and Environmental Sanitation programs of the U. S. Operations Missions in Southeast Asia and the Middle East.

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The Department of Civil Engineering, Ohio State University, Columbus, Ohio, prepared a documentary, instructional movie of the 2-1/2 year construction program of the Clarence and Charles Hoover Dam at Columbus, Ohio. The film is 16mm., color, sound, and runs for 17 minutes. It was prepared by the University, Department of Photography, with Professor Kenneth W. Cosens acting as Technical Consultant. The title of the film is, "Story of a Dam." It is available on a limited loan scale by writing to Professor Cosens.

DID YOU KNOW THAT—

S. 928, an Act to provide research and technical assistance relating to air-pollution control, was signed by the President on July 14. The Act, now known as Public Law 159, authorizes the appropriation annually up to $5,000,000 for five fiscal years beginning July 1, 1955 for grants-in-aid, contracts, and training and demonstration projects as well as research, under direction of the Secretary of the Department of Health, Education, and Welfare and the Surgeon General of the PHS.

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The Ninth Municipal and Sanitary Engineering Conference will be held at the University of Florida in Gainesville, April 17-18, 1956. "Atmospheric Pollution" is the subject of this conference.

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S. 890, a bill to extend and strengthen the Federal Government's participation in water pollution control activities, was passed by the U. S. Senate on July 14, 1955 and is now being considered by the House. It is designed to replace Public Law 845, enacted in 1948 and scheduled to expire June 30, 1956.

The amended bill includes important new authorities including provision for a broadened research effort by means of contract research, research grants, and fellowship grants; for financial grants to support state programs; for PHS assistance to other Federal agencies in abating pollution from Federal institutions; and for a clarified procedure for Federal-State cooperation for solution of interstate pollution problems.

DID YOU KNOW THAT - -

BLAIR I. BURNSON, Executive Assistant to the General Manager of the East Bay Municipal Utility District, Oakland, California, died after a short illness on October 26, 1955. Mr. Burnson was with the District since his graduation from the University of California in 1933. Prior to his last position, he was Supervising Sanitary Engineer for several years. He was active in ASCE, AWWA, and FSIWA affairs, and was vice president of the San Francisco Chapter of ASCE at the time of his death. He published many articles—the latest of which, "Procedures for Handling Water Quality Complaint Investigations," has been received with interest in California and is being published by the California Section of AWWA.

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The University of Florida has been issuing a quarterly bulletin entitled "Sanitary Engineering Progress at the University of Florida" since October 1952. This bulletin reports on the status of research at the University and other information of interest to Sanitary Engineers. Its editor is E. R. HENDRICKSON who has agreed recently to serve as Associate Editor of the SED Newsletter and will report items of interest from his part of the country.

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Mr. CHARLES RICHHEIMER, Jacksonville, Florida, was elected president of the Florida Sewage and Industrial Wastes Association at the annual meeting held in November. Mr. M. E. DAWKINS, Jacksonville, was elected Secretary-Treasurer of the organization.

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Mr. E. R. HENDRICKSON is completing his term of office as president of the Gainesville Sub-Section, ASCE. He also serves as editor of the Florida Section News.

DID YOU KNOW THAT - -

Dr. G. A. ROHLICH, Madison, Wisconsin, was awarded the 1955 Harrison P. Eddy Medal by the FSIWA for outstanding research in the field of sewage treatment.

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Professor JOHN R. SNELL, Head, Department of Civil Engineering, Michigan State University, East Lansing, Michigan, is leaving the University on January 1, 1956. He will open his own consulting engineering office, John R. Snell and Associates, at East Lansing.

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Mr. M. P. CRABILL, Superintendent of Purification, Indianapolis Water Company, was promoted December 15 to a newly-created position of Manager of Operations of the Water Company. In his new capacity, Mr. Crabill will be directly responsible for all matters pertaining to the operation and maintenance of purification, pumping and distribution departments.

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ASCE Members B. A. Poole, S. M. Everts and D. P. Roberts have been named to a 12-member Advisory Committee of state officials by Lewis L. Strauss, Chairman of the Atomic Energy Commission. The state officials representing state agencies such as Health, Labor, and Legal Departments will consult with the Commission on regulations concerning health and safety aspects of private atomic energy activities.

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One major virtue in telling the truth is that you don't have to keep track of what you say.

—Anon

ENGINEERING ASPECTS OF FOOD SANITATION

JAMES A. WESTBROOK

A review of the results of a 1953 survey of professional sanitary engineering interests indicates that less than 10% of sanitary engineers among ASCE members showed major interest in food sanitation. By comparison we find that about 75% showed major interests in water and sewage works.

Those of us in this 10% category who concern ourselves with food sanitation wonder why others are not more interested in this expanding field. The problems of food sanitation are increasing daily because of the new foods being introduced by new processes. Years ago, most of our foods were mixed and prepared in the home kitchen, whereas today, practically everything comes prepared and ready for serving.

The establishment of large plants for the preparation of foods and foodstuffs has created many engineering problems. Let's just consider a few:

1. Food processes in many instances require either large volumes of water or reuse of water when the supply is inadequate. Suitable means of safeguarding the food product as well as the water supply must be considered.
2. Disposal of food plant wastes is becoming of major importance in keeping with nationwide water pollution activities. Studies of waste preventive measures may result in a reduction in the actual waste treatment problem.

3. The use of cleaned-in-place methods of cleaning pipe lines and equipment presents problems of hydraulics in design and in plant operation. One such problem is that of cleaning of a piece of equipment in place when equipment was not designed for cleaning except by disassembly.

4. The use of automation is now being applied in food processing plants. The sanitary engineer should look at such processes from a sanitary standpoint and concern himself with the need for adequate safeguards and controls.

5. The use of radioisotopes for food processing, such as sterilization or pasteurization of foods, indicates that the sanitary engineer should expand activities to include application of radiation sources to food processing.

If we expect to have good food sanitation control in the food industry, the profession needs to become more acquainted with the problems involved. The sanitary engineer should keep informed of changes in food technology affecting food sanitation so that he can contribute the proper leadership in this field of environmental control. The problems encountered are frequently complex and suitable solutions usually require the application of all facets of engineering.

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When nothing seems to help, I go and look at a stone-cutter hammering away at his rock, perhaps a hundred times without as much as a crack showing in it. Yet, at the hundred and first blow it will split in two, and I know it was not that last blow that did it, but all that had gone before.

—Jacob A. Riss

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Be generous with kindly words, especially about those who are absent.

Every day look at a beautiful picture, read a beautiful poem, listen to beautiful music, and, if possible, say some reasonable thing.

—Goethe

PLANS FOR CERTIFICATION PROGRESSING

The certification of sanitary engineers came one step nearer to realization on October 21, 1955 when the American Sanitary Engineering Inter-Society Board was incorporated for this purpose.

Under the leadership of Professor Earnest Boyce of the University of Michigan the Joint Committee for Advancement of Sanitary Engineering prepared the proposal for the establishment of the American Sanitary Engineering Inter-Society Board, Inc.

The inter-society Board of Trustees will consist of eighteen members, three each to be nominated by the ASCE, APHA, the American Water Works Association, Federation of Sewage and Industrial Waste Assn. and the American Society for Engineering Education and three members without nomination from societies or representatives of interest in sanitary engineering not provided for by the initial nominating society.

The Members of the Board as now organized is as follows:

ASCE - Earnest Boyce, Thomas R. Camp, W. A. Hardenburgh

APHA - Mark Hollis, George O. Pierce, Clarence I. Sterling
ASEE - Gilbert H. Dunstan, J. E. Kiker, Jr., Rolf Eliassen
AWWA - W. R. LaDue, R. E. Stiemke, R. J. Faust
FSIWA - R. E. Lawrence, R. S. Rankin, Dwight F. Metzler
AT LARGE - Alvin S. Meyer, Allen D. Brandt, Francis B. Elder

Further additional nominating societies may be added. There have been some serious questions raised with regard to full scale industrial hygiene representation on the inter-society board. Action has been taken to emphasize that the Industrial Hygiene Association, as well as individuals with outstanding competence in industrial hygiene should have a voice in the evaluation of qualifications of those sanitary engineers having special interest in industrial hygiene activities.

The inter-society board will sponsor a sanitary engineering specialty committee consisting of not less than three members of the board and not more than three members selected on the basis of special qualifications. Those presently serving are: Raymond J. Faust, chairman; Francis B. Elder, secretary; and J. E. Kiker, Jr., Harvey F. Ludwig, Allen D. Brandt, Harold B. Gotaas, Thomas R. Camp and R. E. Lawrence.

Provision is made for dividing the specialty committee into sub-committees to evaluate qualification of persons in the various separate fields of sanitary engineering. These specialty committees will act for the board reviewing the applications for certification and will recommend to the board those applicants who should be issued certificates as specialists in the various fields of sanitary engineering. All persons so certified by the inter-society board will automatically become members of an American Academy of Sanitary Engineers.

For the first year following incorporation of the board registered professional engineers who have had a minimum of fifteen years of experience and have achieved a high standing in sanitary engineering may be excused from examination.

Later, examinations will be given in three parts consisting of: A written phase covering the knowledge of the applicant in the broad field of sanitary engineering and principles of public health; a written examination designed to test knowledge and ability in the field in which he claims special proficiency and appearance before the sanitary engineering specialty committee or its representatives with an accompanying oral test to develop fully and satisfactorily the qualifications of the applicant.

This procedure follows very closely that used by the various American specialty boards in medicine, the American Board of Veterinary Preventive Medicine and the American Board of Nutrition. The ASCE has authorized a non-interest loan to the inter-society board of $7,500 and has made space available for offices in New York for administrative facilities and records of the board.

The certification program will offer a definitely outlined plan for career progression to be a universally recognized method of recognition. In addition to having influence on educational patterns for engineers engaging in the life science area, if the experience in the medical area is any indication, it will certainly influence career patterns within the various agencies. It provides a means of identifying special competence beyond that indicated by academic degree so that individual skills will be better appreciated and utilized. It should tend to raise the stature of all engineers, both those who are certified

and those who are working toward such certification. From an overall engineering professional viewpoint, the inter-society board may ultimately become a focal point for all of the diverse interests in sanitary engineering.

Work is now progressing on the many details which necessarily must be settled before applications can be accepted. It is anticipated that application forms will be ready by April 1, 1956. The next issue of this Journal will carry further details.

Bulletin
of
The American Sanitary Engineering
Intersociety Board
Incorporated

1955

Certificate of Incorporation
and
Bylaws

Office of the Secretary
33 West 39th St.
New York 18, N.Y.

Board Members, Officers and Sponsoring Organizations

The American Public Health Association

Mark D. Hollis, Asst. Surgeon General & Chief Engr.
U. S. Public Health Service
H.E.W. Bldg., South
Washington 25, D. C.

George O. Pierce, Chief, Environmental Sanitation Br.
Pan-American Sanitary Bureau
1501 New Hampshire Ave., N. W.
Washington 6, D. C.

Clarence I. Sterling, Director, Div. of Sanitary Engrg.
Massachusetts Dept. of Public Health
Boston, Massachusetts

The American Society for Engineering Education

Gilbert H. Dunstan, Prof. of Sanitary Engineering
College of Engineering
State College of Washington
Pullman, Washington

J. E. Kiker, Jr., Prof. of Sanitary Engineering
Civil Engineering Dept.
University of Florida
Gainesville, Florida

Rolf Eliassen, Prof. of Sanitary Engineering
Room 1-138
Massachusetts Institute of Technology
Cambridge 39, Massachusetts

The American Water Works Association

Wendell R. LaDue, Chief Engineer and Supt.
Bureau of Water and Sewerage
404 Municipal Bldg.
Akron 8, Ohio

Robert E. Stiemke, Director, School of Civil Engineering
Georgia Institute of Technology
Atlanta, Georgia

Raymond J. Faust, Executive Ass't. Sec'y.
American Water Works Association
521 Fifth Avenue
New York 17, N. Y.

The Federation of Sewage and Industrial Wastes Associations

R. E. Lawrence, Black and Veatch, Consulting Engrs.
4706 Broadway
Kansas City 2, Missouri

R. S. Rankin, Director
Sanitary Engineering Technical Division
Dorr-Oliver Incorporated
Barry Place
Stamford, Connecticut

Dwight F. Metzler, Chief Engineer, State Board of Health
Lawrence, Kansas

The American Society of Civil Engineers

Thomas R. Camp, Camp, Dresser & McKee
Consulting Engineers
6 Beacon Street
Boston, Massachusetts

W. A. Hardenbergh, Editor, Public Works
200 South Broad Street
Ridgewood, New Jersey

Earnest Boyce, Professor of Sanitary Engineering
University of Michigan
304 West Engineering Building
Ann Arbor, Michigan

Trustees at Large Elected by the Board

Allen D. Brandt, Chief Industrial Hygiene Engr.
Bethlehem Steel Co., Inc.
Bethlehem, Pennsylvania

Alvin F. Meyer, Jr., Lt. Col. USAF(MSC)
1701 South 78th Street
Omaha 6, Nebraska

Francis B. Elder, Engineering Associate
American Public Health Assoc.
1790 Broadway
New York 19, N. Y.

Officers - 1955-56

Chairman	Earnest Boyce
Vice Chairman	W. A. Hardenbergh
Treasurer	R. S. Rankin
Secretary	Francis B. Elder

Sanitary Engineering Specialty Committee
Francis B. Elder, Secretary
33 West 39th Street
New York 18, N. Y.

Certificate of Incorporation
of
The American Sanitary Engineering
Intersociety Board
Incorporated

1955

CERTIFICATE OF INCORPORATION OF THE AMERICAN SANITARY ENGINEERING INTERSOCIETY BOARD

Preamble:

For the purpose of associating to establish a corporation for the conduct and furtherance of the objects and purposes hereinafter stated, under the provisions of and subject to the requirements of the laws of the State of Delaware (particularly "The General Corporation Law of the State of Delaware"), we the undersigned, do make and file this certificate of incorporation and do hereby certify as follows:

Article I:

The name of the corporation, hereinafter called the Corporation, is "The American Sanitary Engineering Intersociety Board (Incorporated)."

Article II:

The respective names of the county and of the city within the county in which the principal office of the Corporation is to be located in the State of Delaware are the County of New Castle and the City of Wilmington. The name of the resident agent of the Corporation is The Corporation Trust Company. The street and number of said principal office and the address by street and number of said resident agent is 100 West Tenth Street, Wilmington 99, Delaware.

Article III:

The nature of the business of the Corporation and the objects and purposes to be promoted or carried on by it are as follows:

a. To improve the practice, elevate the standards and advance the cause of sanitary engineering;

b. To grant and issue to engineers duly licensed by law to practice engineering, certificates of special knowledge in sanitary engineering or in any field thereof, and to revoke certificates so granted or issued; but no certificate granted or issued by the Corporation shall, of itself, confer or purpose to confer, upon any person any legal qualification or privilege or license or registration to practice sanitary engineering or any other profession; or shall purport to be issued under or in pursuance of, or by virtue of, any governmental sanction or authority;

c. To receive and act upon applications for such certificates of special knowledge in sanitary engineering; to establish, maintain and, from time to time, alter and amend, rules and regulations, standards and qualifications for the granting or issuance of, and the retention of such certificates; to determine by examination, investigation or otherwise, the fitness of applicants for, and the holders of, such certificates; to prepare, provide and

conduct examinations, oral, written and other, for the purpose of, or in connection with, such determination of fitness, and to determine the results of any such examinations; to arrange for and conduct investigations as may be deemed necessary or desirable for, or in connection with, carrying out any of the purposes or objects of the Corporation; and to require the payment of, and to collect and receive from each such applicant or examinee, such fees for application, examination, investigation and determination of fitness as may, from time to time, be prescribed by the Board of Trustees or the by-laws of the Corporation;

d. To purchase, rent, hire or otherwise acquire, and to provide, erect, make, maintain, establish and operate offices, and other facilities, and all necessary or convenient equipment for, and accessories to any or all thereof, to engage and employ such assistance as may be deemed necessary or desirable in connection with any of such purposes or objects; and to pay reasonable compensation for services rendered to the Corporation;

e. To furnish to the public or to interested organizations lists of engineers having special knowledge in sanitary engineering, as evidenced by certificates granted by the Corporation;

f. To keep and maintain a register of holders of certificates granted by the Corporation, such roster to be known as the American Academy of Sanitary Engineers;

g. Except as specifically prohibited by law, to accept any gift, grant, endowment, devise or bequest made to the Corporation at any time to further its general purposes;

h. To acquire, hold, own, develop, operate, sell, transfer, exchange, mortgage or dispose of any property, real or personal, subject to law;

i. To borrow money for any of the purposes of the Corporation from time to time and without limit as to amount; and to secure any such loan or obligation by mortgages or pledges of all or any part of the assets of the Corporation;

j. To enter into, make, perform, carry out, cancel or rescind contracts for any lawful purpose pertaining to the objects and purposes of the Corporation;

k. To conduct its activities and affairs, or any of them, and to have offices within or outside the State of Delaware;

l. To do, in the State of Delaware, or elsewhere, alone or in conjunction with others, everything necessary, desirable, suitable, convenient or proper for the accomplishment of any of the objects or purposes herein specified, or incidental to them which are not inconsistent with the laws of the State of Delaware.

It is the intention that the objects and purposes set forth in the foregoing clauses shall not, except as specified herein, be in any way limited by reference to or inference from any other clauses in this or any other article of the Certificate of Incorporation, but that the objects and purposes specified in each of said clauses shall be regarded as independent objects and purposes.

It is also intended that the foregoing clauses shall be construed as powers, as well as objects and purposes, and the foregoing enumeration of specific powers shall not be held to limit or restrict in any manner the general powers of the Corporation; and generally the Corporation shall be authorized to exercise and enjoy all other powers, rights and privileges granted by the laws of the State of Delaware, now or hereafter in force to Corporations not organized for pecuniary profit; and the enumeration herein of certain powers is not intended to be exclusive of, or a waiver of, any of the powers, rights or privileges granted or conferred by the laws of the State of Delaware now or hereafter in force.

Nothing in this Certificate of Incorporation shall be construed as authorizing the Corporation to issue bills, notes or other evidence of debt for circulation as money, or to carry on the business of receiving deposits of money, or of buying gold or silver bullion or foreign coins; or as authorizing the Corporation to confer academic or honorary degrees.

Article IV:

The Corporation is not organized for pecuniary gain or profit. It shall have no corporate stock and shall not have authority to issue capital stock. The conditions, qualifications and terms of membership in the Corporation shall be as hereinafter set forth and, subject to the provisions herein, as may from time to time be provided in the bylaws.

a. Nominating Societies: Except as otherwise provided in this Article, no person shall be a member of the Corporation unless he shall have been nominated for membership by one of the nominating societies hereinafter provided for, and shall have been elected to membership pursuant to the provisions of this Article. The initial nominating societies shall be: The American Society of Civil Engineers; The American Public Health Association; The American Water Works Association; The Federation of Sewage and Industrial Wastes Associations; and the American Society for Engineering Education. The Board of Trustees may at any time by a resolution adopted by an affirmative vote of two-thirds of all Trustees in office at the time (1) designate one or more additional nominating societies which shall have as aims the advancement of knowledge in some field of sanitary engineering and elect to membership not more than three (3) persons from among the persons nominated by each such additional nominating society; or (2) designate and elect to membership not more than three (3) persons without nomination by any nominating society; provided, in each case, any such resolution shall also increase the authorized number of members of the Corporation; and further provided that there shall not at any time be more than three (3) members of the Corporation who shall not have been nominated by a nominating society. In case any nominating society shall notify the Chairman or the Secretary of the Corporation, in writing, of the withdrawal of such nominating society, such nominating society shall cease to be a nominating society at the time specified in the notification; or if no such time is specified, as of the date of receipt of the notification by the Chairman or Secretary.

b. Number of Members and Terms: The authorized number of members of the Corporation shall be fifteen (15), but such number may be increased, or may be decreased to not less than five (5) at any time by the Board of Trustees, provided that the authorized number shall not at any time be less

than the number of nominating societies. Subject to the provisions of subparagraph d of this Article, the term of membership of each initial member of the Corporation shall be determined by drawing lots, pursuant to the provisions of subparagraph c. The term of membership of each member of the Corporation shall otherwise be three (3) years, except that a member elected to succeed another member upon the death, resignation or removal of such other member shall serve for the balance of the term for which such other member was elected or appointed. Members nominated by any additional nominating society shall initially draw lots, as elsewhere provided, to determine the length of their respective terms.

c. Initial Members: Each of the initial nominating societies and each additional nominating society may nominate and appoint from among their own membership, as members of the Corporation, three (3) persons qualified for membership in the Corporation under the provisions of subparagraph d of this Article. One-third of the initially nominated members shall hold membership in the Corporation for a term ending at the annual meeting of the members of the Corporation following their election; one-third for a term ending one year thereafter; and one-third for a term ending two years thereafter, all as shall be determined by the drawing of lots among each three members representing each nominating society, so that one initially nominated member from each nominating society shall hold office for three years, one for two years and one for one year.

d. Qualifications of Members: Each member of the Corporation at the time of his election shall be (1) an engineer duly licensed by law to practice engineering; (2) except in the case of members appointed by the Board of Trustees, a member in good standing of the nominating society by which he is nominated; and (3) except during an initial period of five (5) years from the date of the first annual meeting of the members of the Corporation, a holder of a certificate issued by the Corporation of special knowledge in sanitary engineering or a particular field thereof. Any member whose license to practice engineering shall be suspended or revoked, or who shall cease to be a member in good standing of the nominating society by which he has been nominated, or whose certificate issued by the Corporation of special knowledge in sanitary engineering or any special field thereof shall be revoked, shall forthwith cease to be a member of the Corporation. In case any nominating society shall withdraw as such, each member of the Corporation who shall have been nominated for membership in the Corporation by such nominating society shall cease to be a member thereof at the time such withdrawal becomes effective. The granting or issuance by the Corporation of a certificate of special knowledge in sanitary engineering or in any particular field thereof does not, in itself, constitute such a person a member of the Corporation or entitle such person to any of the rights or privileges of membership in the Corporation.

e. Nomination of Members: In advance of each annual meeting of the members of the Corporation and of each special meeting of the members at which members or a member of the Corporation may be elected under the provisions of subparagraph f of this Article, each nominating society may submit to the Chairman or the Secretary of the Corporation the nomination in writing of one or more members of such nominating society, each qualified under the provisions of subparagraph d of this Article, for membership in the

Corporation, in respect of each membership in the Corporation which is to be filled at such meeting by the election of a nominee of such nominating society. If any such nominating society shall fail to submit such nomination at least two days prior to the date of such meeting, the Board of Trustees may designate any qualified member of such nominating society as a nominee thereof for such membership; and if no such nomination and no such designation shall be made, or if no person so nominated or designated shall receive sufficient votes at such meeting to elect him to membership in the Corporation, the members of the Corporation present at such meeting in person or by proxy may elect any other qualified member of such nominating society as a member of the Corporation to fill any membership which is to be filled at such meeting by the election of a nominee of such nominating society; and in any such case each person so designated by the Board of Trustees or elected by the members shall be deemed for all purposes of this certificate of incorporation to have been nominated by such nominating society. Without limitation of the preceding provisions of this subparagraph (e), each member of the Corporation whose term of membership expires at any meeting, otherwise than by his resignation or removal or by reason of the provisions of subparagraph (d) of this Article, shall be eligible for reelection to membership at such meeting without further nomination, provided another nomination shall not have been forwarded by the nominating society.

f. Election of Members: Members of the Corporation shall be elected at each annual meeting of the Corporation members to succeed members whose terms of membership expire at such meeting; and subject to the provisions of subparagraph (a) of this Article, to fill other vacancies in the membership of the Corporation, whether resulting from an increase in the authorized number of members of the Corporation or from the designation of an additional nominating society; and at any special meeting of members, the notice of which shall include a statement that a member or members may be elected at such meeting, or at which all the then members shall be present in person or by proxy, a member may be elected to fill the place of any member who shall have died or resigned or been removed, or whose membership shall have terminated, and whose place remains vacant; provided, however, that no member shall be elected at any meeting to succeed or fill the place of a member whose membership shall have been or shall then be abolished by a reduction of the authorized number of members of the Corporation. Each person elected to succeed or fill the place of a member who shall have been nominated by or designated for membership from a nominating society shall be a person nominated by or designated for membership from such nominating society. Each person elected to succeed or fill the place of a member who shall not have been nominated by any nominating society, may be chosen from those eligible under other provisions of this Certificate of Incorporation to membership in the Corporation. The affirmative vote of a majority of all the members of the Corporation at the time shall be necessary and sufficient for the election of any member; provided, however, that each initial member shall be deemed to be elected without vote of the members.

g. Resignation and Removal: Any member of the Corporation may at any time resign by giving written notice to the Chairman or the Secretary of the Corporation; and, unless otherwise specified in such notice of resignation, the acceptance of such resignation shall not be necessary to make it effective.

The Board of Trustees may at any time, by a vote of the majority of its whole number of members, remove any member of the Corporation from membership therein if, in the judgment of the Board, such member shall be unable or unfit, by reason of illness or incapacity or for any other reason, to carry out and perform the duties of a member and Trustee of the Corporation.

Article V:

The names and places of residence of each of the incorporators are as follows:

Alvin F. Meyer, Jr.
1701 So. 73th Street
Omaha, Nebraska

William H. Wisely
33 W. 39th Street
New York, N. Y.

Thomas A. Marshall, Jr.
33 W. 39th Street
New York, N. Y.

Article VI:

The Corporation shall have perpetual existence.

Article VII:

The private property of the members of the Corporation shall not be subject to the payment of Corporate debts to any extent whatever.

Article VIII:

For the management and conduct of the activities of the Corporation and in further definition, limitation and regulation of the powers of the Corporation and its members and Trustees, it is further provided:

a. The members of the Corporation shall be the Trustees of the Corporation and the number of Trustees shall be the same as the number of the members, and any increase or decrease in the authorized number of its members shall effect a like increase or decrease in the number of the trustees; but in no case shall there be less than five (5). Each member shall be a Trustee of the Corporation and shall hold office from the date of his election as a member until his term of membership expires, and no longer. A majority of the whole number of Trustees shall constitute a quorum for the transaction of business, unless the bylaws prescribe that a different number shall constitute a quorum.

b. In furtherance and not in limitation of the powers conferred by the State of Delaware or by any other provision of this Certificate of Incorporation, the Board of Trustees is expressly authorized and empowered:

(1) To make, alter, amend, and repeal the bylaws of the Corporation in any manner not inconsistent with the laws of the State of Delaware or with this Certificate of Incorporation;

(2) To hold meetings and have an office or offices outside the State of Delaware, if the bylaws so provide;

(3) To carry on all activities enumerated in the Third Article of this Certificate of Incorporation;

(4) To remove any officer of the Corporation at any time in such manner as shall be provided in the bylaws,

c. In addition to the powers and authorities herein-before or by the laws of the State of Delaware expressly conferred upon it, the Board of Trustees may exercise all such powers and do all such acts and things as may be exercised or done by the Corporation, subject, nevertheless, to the express provisions of said laws, of the Certificate of Incorporation, and of the by-laws of the Corporation;

d. In the absence of fraud, no contract or other transaction between the Corporation and any other corporation shall in any way be invalidated or otherwise affected by the fact that one or more of the trustees of the Corporation are trustees, directors or officers of such other corporation or are pecuniarily interested therein; but in all cases such pecuniary interest shall be disclosed to or shall have been known to the Board of Trustees before any action is taken upon any such contract or transaction;

e. No person shall be liable to the Corporation for any loss or damage suffered by it on account of any action taken or omitted by him as a Trustee or officer of the Corporation in good faith if such person (a) exercised or used the same degree of care and skill as a prudent man would have exercised or used under the circumstances in the conduct of his own affairs; or (b) took or omitted to take such action upon advice of counsel to the Corporation or upon statements made or information furnished by officers or employees of the Corporation which he had reasonable grounds to believe.

The provisions of this Article shall be in addition to and not in limitation of any other rights, powers, indemnities, or limitations of liability.

Article IX:

The income and property of the Corporation shall be applied solely toward the furtherance and accomplishment of the objects and purposes of the Corporation set forth in this Certificate of Incorporation, and no portion thereof shall be paid or applied, directly or indirectly, by way of dividend, bonus or otherwise, to or by way of profit to members of the Corporation; provided, however, that nothing herein shall be construed to prevent payment of proper compensation or remuneration to any member or trustee of the Corporation for any property, premises or equipment sold, rented or hired by him to the Corporation, or for services rendered to it by him otherwise than as a member and/or trustee, or interest not exceeding five percent per annum on money lent or advanced by him, or the repayment to or reimbursement of any member, trustee or officer of traveling expenses and other out-of-pocket disbursements, and expenses paid or incurred by him in connection with the affairs of the Corporation, or reimbursement for expenses incurred or paid by any officer or employee of the Corporation other than a member or trustee. No trustee of the Corporation shall receive any fee or salary for his services as such or for services as an officer of the Corporation, and no remuneration or other benefit, except as above provided. If upon dissolution of the Corporation,

there shall remain any property after satisfaction of all indebtedness, such property shall not be distributed among the members of the Corporation but shall be given or transferred to one or more nonprofit associations or institutions having objectives generally similar, such as shall be selected by the members of the Corporation at a meeting held at or before the time of such dissolution. In default thereof, the decision shall be made by such courts as may have or acquire jurisdiction; or the property and assets may be donated to some charitable object.

Article X:

At any time and from time to time any of the provisions of this Certificate of Incorporation may be amended, altered or repealed, or other provisions authorized by the laws of the State of Delaware at the time in force may be added or inserted, in the manner prescribed by such laws and all rights at any time conferred by this Certificate of Incorporation are granted subject to the provisions of this Article X.

We, the undersigned, being each of the incorporators hereinbefore named for the purpose of forming a corporation to do and carry on business anywhere under the authority of the General Corporation Law of the State of Delaware, known as Title 8 of the Delaware Code, 1953, and the acts amendatory thereof and supplemental thereto, do make this certificate and do hereby declare and certify that the facts herein stated are true, and accordingly have hereunto set our hands and seals this 21st day of October A.D. 1955.

(Signed by the incorporators)

Bylaws
of
The American Sanitary Engineering
Intersociety Board
Incorporated
1955

BYLAWS
OF
THE AMERICAN SANITARY ENGINEERING INTERSOCIETY BOARD INCORPORATED

Article I: OFFICES

Section 1. Principal Office. The principal office of the Corporation in the State of Delaware shall be at 100 West 10th Street in the City of Wilmington, County of New Castle, and the name of the resident agent in charge thereof is the Corporation Trust Company.

Section 2. Other Offices. The Corporation may have such other office or offices, either within or without the State of Delaware, as the Board of Trustees may from time to time appoint or the affairs of the Corporation may require.

Article II: MEMBERS

Section 1. Election of Members. Members of the Corporation, other than the initial members shall be elected by the members of the Corporation at the annual meeting of members, except that at a special meeting of members, the notice of which shall include a statement that a member or members may be elected at such meeting, a member may be elected to fill the place of any member who shall have died or resigned or been removed since the last preceding annual meeting; subject, however, to the provisions of the Certificate of Incorporation. The affirmative vote of a majority of all the members of the Corporation at the time shall be necessary and sufficient for the election of any member. Voting for the election of members shall be by ballot.

Section 2. Terms of Membership. The respective terms of membership of the members of the Corporation shall be as provided in the Certificate of Incorporation.

Section 3. Annual Meeting. An annual meeting of members of the Corporation shall be held at such time and place as the Board of Trustees shall determine for the purpose of electing members and trustees of the Corporation and for the transaction of such other business as may properly be brought before the meeting.

Section 4. Special Meetings. Special meetings of the members may be called at any time by the Chairman or a Vice Chairman or by at least one-third of the members, except as otherwise provided by law. A member elected at a special meeting at which, under Section 1 of this Article II, a member or members may be elected, may also be elected a Trustee at such meeting.

Section 5. Place of Meetings. The places of holding any meeting for the election of trustees shall not be changed within twenty (20) days next before the date on which the election is to be held; and a notice of any change in the place of such a meeting shall be given to each member of the Corporation at

least twenty (20) days before the date on which such meeting is to be held, in person or by letter mailed to his last-known post office address. All other meetings of members shall be held at such places, within or without the State of Delaware, as may from time to time be fixed by the Board of Trustees or as shall be specified in the respective notices or waivers of notice thereof.

Section 6. Notice of Meetings. Except as otherwise expressly required by law or hereinafter provided, notice of each meeting of the members, whether annual or special shall, at least twenty (20) days before the day on which the meeting is to be held, be given to each member by delivering a written or printed notice thereof (which, unless otherwise provided by law or by the Certificate of Incorporation or by these bylaws, need not state the purpose or purposes of such meeting) to him personally or by mailing such notice in a postage prepaid envelope addressed to him at his last-known post office address. Nevertheless, notice of any meeting of members need not be given to any member who shall attend such meeting in person, or by proxy, or who shall in writing or by telegraph, cable, wireless, or radio waive notice thereof either before or after such meeting. Except when expressly required by law, notice of any adjourned meeting of the members need not be given, and no publication of any notice of a meeting of the members shall be required.

Section 7. Quorum. At all meetings of the members (except where otherwise provided by law or by the Certificate of Incorporation) a majority of the members of the Corporation at the time, present in person or by proxy, shall constitute a quorum for the transaction of business. In the absence of a quorum at any such meeting or any adjournment thereof, or in the absence from any meeting of the number of members required by the laws of the State of Delaware or by these bylaws for action on any given matter, the members present in person or by proxy, or, in the absence of all the members, the Secretary of the Corporation, may adjourn such meeting from time to time. At any such adjourned meeting at which a quorum is present any business may be transacted which might have been transacted at the meeting as originally called.

Section 8. Organization. At each meeting of the members the Chairman, or, in his absence, such other officer or member of the Corporation as shall be chosen chairman of such meeting by a majority of the members present in person or by proxy, shall act as chairman thereof and preside thereat, and the Secretary of the Corporation, or, if he shall be absent from such meeting or if he shall be chosen pursuant to the provisions of this Section 8 to act as chairman of such meeting, the person whom the chairman of such meeting shall appoint secretary of such meeting, shall act as secretary of such meeting and keep the minutes thereof.

Section 9. Voting. Each member of the Corporation shall, at each meeting of the members, be entitled to one vote in person or by proxy. Any member may vote in person or by his proxy appointed by an instrument in writing subscribed by such member and delivered to the secretary of the meeting; provided, however, that no proxy shall be voted on after one (1) year from its date. At all meetings of the members all matters, except those the manner of deciding upon which is otherwise expressly regulated by law or by the Certificate of Incorporation or by these bylaws, shall be decided by the vote of a majority of the members present in person or by proxy, a quorum being

present. The vote upon the election of members, and, upon the demand of any member, the vote upon any other matter before the meeting, shall be by ballot, signed by the member voting or his proxy, and, if signified by a proxy, showing the members whose votes are cast. Except as otherwise provided by law, no judges or inspectors of election shall be required.

Section 10. List of Members. It shall be the duty of the Secretary or other officer of the Corporation who shall have charge of its membership ledger to make, at least ten (10) days before every meeting of the members called to be held for the election of trustees of the Corporation, a complete list of the members entitled to vote thereat, arranged in alphabetical order. Such list shall be open at the place where such meeting is to be held for such ten (10) days to the examination of any member and it shall be produced and kept at the time and place of such meeting and election during the whole thereof and subject to the inspection of any member present thereat. Upon the wilful neglect or refusal of the trustees to produce such list at any election they shall be ineligible to any office at such election. The original or duplicate membership ledger shall be the only evidence as to who are the members of the Corporation entitled to inspect such list or the books of the Corporation or to vote in person or by proxy at such election.

Article III: BOARD OF TRUSTEES

Section 1. General Powers; "Board." The property, business, and affairs of the Corporation shall be managed by a Board of Trustees. Wherever used in these bylaws, the term "the Board" shall be deemed to mean such Board of Trustees.

Section 2. Number, Qualifications, and Terms of Office. The number of trustees shall be the same as the number of members of the Corporation, and any increase or decrease in the number of members shall effect a like increase or decrease in the number of trustees; but the number of trustees shall in no case be less than five (5). Each trustee shall be a member of the Corporation, and shall hold office from the date of his election as a trustee until his term of membership expires, and no longer.

Section 3. Organization. At each meeting of the Board of Trustees the Chairman, or, in his absence, a chairman chosen by a majority of the trustees present, shall act as chairman of such meeting and preside thereat. The Secretary, or, in his absence, or if he shall be chosen chairman of such meeting, any person appointed by the chairman of the meeting, shall act as secretary of such meeting and keep the minutes thereof.

Section 4. Places of Meetings. The Board of Trustees may hold its meetings at such place or places within or without the State of Delaware as the Board may from time to time by resolution determine or as shall be specified in the respective notices or waivers of notice thereof.

Section 5. Annual Meeting. As soon as practicable after each annual meeting of members of the Corporation the Board of Trustees shall meet for the purpose of electing officers of the Corporation and for the transaction of other business. Notice of such meeting of the Board need not be given if it is held at the same place at which such annual meeting of members was held and immediately after the close of such annual meeting. Such meeting may

be held at any other time or place which shall be specified in a notice given as hereinafter required for special meetings of the Board or in a waiver of notice thereof.

Section 6. Regular Meetings. Regular meetings of the Board of Trustees shall be held at such times as the Board may from time to time by resolution determine. Except as otherwise required by law, notices of regular meetings need not be given.

Section 7. Special Meetings; Notice; Waiver. Special meetings of the Board of Trustees shall be held whenever called by the Chairman or by a majority of the trustees at the time in office. Except as otherwise provided by law, a notice of each such special meeting, which shall state the time and place of such meeting but, except as otherwise expressly provided by law or by these by-laws, need not state the purposes thereof, shall be mailed to each trustee, addressed to him at his last-known post office address, at least seven (7) days before the day on which such meeting is to be held, or shall be sent addressed to him at his residence or usual place of business by telegraph, cable, wireless, or radio, or be delivered personally or by telephone, not later than the second day before the day on which such meeting is to be held. Nevertheless, notice of any meeting of the Board neet not be given to any trustee if he be present at such meeting or if he shall in writing or by telegraph, cable, wireless, or radio waive notice thereof either before or after such meeting; and any meeting of the Board shall be a legal meeting without any notice thereof having been given if all the trustees at the time in office are present thereat.

Section 8. Quorum and Manner of Acting. At all meetings of the Board of Trustees, a majority of the trustees at the time in office, shall constitute a quorum for the transaction of business, and the act of a majority of the trustees present at any meeting of the Board at which a quorum is present shall be the act of the Board of Trustees except as may otherwise be specifically provided by law or by the Certificate of Incorporation or by these bylaws. In the absence of a quorum from any meeting of the Board, the trustees present, or, in the absence of all trustees, the Secretary of the Corporation, may adjourn such meeting from time to time. Notice of any adjourned meeting of the Board need not be given. The trustees shall act only as a board, and the individual trustees shall have no power as such.

Section 9. Committees. The Board of Trustees shall have three standing committees, which shall respectively be known by such names, consist of such members of the Board, and others as are hereinafter provided for, and have such powers and duties, as are hereinafter set forth:

The Executive Committee, which shall consist of at least three Trustees including the Chairman, the Vice Chairman, and the Secretary, ex officio, and which shall have power, between meetings of the Board, to exercise all the powers of the Board in the management of the property, business, and affairs of the Corporation, except as otherwise provided by law or by the Certificate of Incorporation or by these by-laws and except such powers as by this Section 9 are committed to any other standing committee; and

The Sanitary Engineering Specialty Committee, which shall consist of not less than three (3) members of the Board of Trustees and not more than (3) persons not members of the Board of Trustees who shall be selected on the basis of special qualification, nominated by the Chairman, and elected by a

majority vote of the Board, and which shall formulate and recommend to the Board from time to time standards of competence to be met by applicants for certificates of special knowledge in each or any field of Sanitary Engineering, and shall prescribe the form and contents of applications for such certificates, investigate and report upon the eligibility of applicants for such certificates, conduct and evaluate the results of examinations of such applicants, and make reports and recommendations to the Board with respect to the granting and issuance of such certificates to applicants therefor, and which may be divided by the Chairman or by the chairman of such Committee into two or more sub-committees to exercise, respectively, the foregoing powers and duties with respect to separate fields of Sanitary Engineering. The Sanitary Engineering Specialty Committee shall represent the Board in all matters relating to examination of applicants for certificates and in recommending certification, but such committee shall not have power to grant or issue any such certificate;

a. Its members shall serve terms of three (3) years each, except that the terms of members initially elected shall be as stated in sub-paragraph b below. No member may serve more than two consecutive terms, whether short or long; and he shall serve for the term or terms appointed, and no longer, subject to the preceding clause of this sentence.

b. The members initially elected to the Specialty Committee shall draw lots to determine their length of service, which shall be one year, two years and three years, respectively; and

The Finance Committee, which shall consist of the Treasurer, ex officio, and two (2) members of the Board appointed by the Chairman, and which shall from time to time recommend to the Board the amount of fees to be paid to the Corporation by applicants for certificates of special knowledge in any field of Sanitary Engineering and shall have general supervision over the financial affairs of the Corporation;

In addition, the Chairman or the Board may, at any time and from time to time designate or authorize the designation of one or more other committees, each of which shall consist of such number of members of the Board, and shall have such name, and may exercise such powers, as shall be specified in the designation thereof; provided, however, that any of or all the powers committed by or pursuant to these bylaws to any standing or other committee may at any time and from time to time be exercised by the Board, and that any action taken or decision or determination made by any committee may be altered, amended, abrogated, overridden, or reversed by the Board at any time before any person dealing with such committee or the Corporation shall have changed his position to his prejudice in reliance upon such action, decision, or determination. Each member of any standing or other committee, except a member ex officio, and except members of the Specialty Committee shall serve as such at the pleasure of the Chairman.

Section 10. Expenses. Each trustee shall be allowed such traveling expenses and other out-of-pocket disbursements and expenses actually paid or incurred by him in connection with attending meetings of the Board of Trustees or otherwise in connection with the activities and affairs of the Corporation as the Board or the Finance Committee shall approve; but no trustee shall be paid any salary or fee for his services as a trustee or for attending meetings of the Board.

Article IV: OFFICERS

Section 1. Principal Officers. The principal officers of the Corporation shall be a Chairman, a Vice Chairman (or Vice Chairmen), a Treasurer, and a Secretary, each of whom shall be elected from among the trustees. Any two offices, but not more than two, may be held by the same person.

Section 2. Election, Term of Office, and Qualifications. The principal officers of the Corporation shall be elected annually by the Board of Trustees. Each principal officer shall hold office until his successor shall have been duly elected, or until his death, or until he shall resign or be removed as hereinafter provided, or until he shall cease to be a trustee, whichever shall first occur.

Section 3. Additional Officers. In addition to the principal officers, the Board of Trustees may appoint, or may delegate to any principal officer the power to appoint, such other officers, including one or more Vice Chairmen, and such agents, as the Board may deem necessary or advisable, each of which officers and agents shall hold office for such period, have such authority, and perform such duties as are provided in these bylaws or as the Board of Trustees may from time to time determine.

Section 4. Removal. Any officer of the Corporation may be removed, either with or without cause, at any time, by resolution adopted by a majority of the whole Board of Trustees, at any meeting, or, except in the case of any principal officer, by any superior officer upon whom such power of removal shall have been conferred by the Board.

Section 5. Resignation. Any officer of the Corporation may at any time resign, by giving written notice of his resignation to the Board of Trustees or to the Chairman or the Secretary; and, unless otherwise specified in such notice of resignation, the acceptance of such resignation shall not be necessary to make it effective.

Section 6. Vacancies. A vacancy in any office resulting from death, removal, resignation, disqualification, or any other cause shall be filled for the unexpired portion of the term in the manner prescribed in these bylaws for regular election or appointment to such office.

Section 7. The Chairman. The Chairman shall have general and active supervision over the activities and affairs of the Corporation, subject, however, to the control of the Board of Trustees. He shall, if present, preside at all meetings of the members and at all meetings of the Board of Trustees; he shall see that all orders and resolutions of the Board are carried out; he may sign, execute, and deliver in the name and in behalf of the Corporation all deeds, mortgages, bonds, contracts, and other instruments authorized by the Board of Trustees, and all certificates of special knowledge in Sanitary Engineering, except in cases where the signing, execution, or delivery thereof shall be expressly delegated by the Board or by these bylaws to some other officer or agent of the Corporation or where any of them are required by law to be otherwise signed, executed, or delivered; and in general he shall perform all duties incident to the office of president of a corporation, and such other duties as may from time to time be assigned to him by the Board of Trustees. If so directed by the Board of Trustees the Chairman shall give bond for the faithful discharge of his duties in such sum and with such security or securities as the Board shall from time to time specify or approve.

Section 8. The Vice Chairmen. Each Vice Chairman shall have such powers and perform such duties as the Board of Trustees or the Chairman may from time to time prescribe, and shall perform such other duties as may be prescribed by these bylaws. At the request of the Chairman, or in case of his absence or inability to act, the Senior Vice Chairman shall perform the duties of the Chairman and, when so acting, shall have all the powers of, and be subject to all restrictions upon, the Chairman.

Section 9. The Treasurer. If so directed by the Board of Trustees, the Treasurer shall give a bond for the faithful discharge of his duties in such sum and with such surety or sureties as the Board shall from time to time specify or approve. He shall:

(a) have charge and custody of, and be responsible for, all funds, securities, notes, and valuable effects of the Corporation; receive and give receipt for moneys due and payable to or receivable by the Corporation from any source whatsoever; deposit all such money to the credit of the Corporation, or otherwise dispose thereof, as the Board of Trustees or the Chairman shall direct; cause such funds to be disbursed by checks or drafts signed as provided in these bylaws; and be responsible for the accuracy of the amounts of, and preserve proper vouchers for, all money so disbursed;

(b) render to the Chairman or the Board of Trustees, whenever required by him or it so to do, an account of the financial condition of the Corporation and of all his transactions as Treasurer;

(c) exhibit at all reasonable times his cash books and other records to the Chairman or to any of the trustees of the Corporation upon application; and

(d) in general, perform all the duties incident to the office of Treasurer and such other duties as may from time to time be assigned to him by the Chairman or the Board of Trustees.

Section 10. The Secretary. The Secretary shall:

(a) keep the minutes of meetings of the members and of the Board of Trustees in one or more books provided for that purpose; and

(b) see that all notices are duly given in accordance with the provisions of these bylaws or as required by law; and

(c) be custodian of all contracts, deeds, and documents of the Corporation, and of all indicia of title to property owned by the Corporation, and of its other corporate records (except accounting records), and of the seal of the Corporation, and see that such seal is affixed to all certificates issued by the Corporation of special knowledge in Sanitary Engineering and to all other documents the execution of which on behalf of the Corporation under its seal is duly authorized in accordance with the provisions of those bylaws, and shall attest such seal by his signature in all cases where such attestation is required; and

(d) see that the books, reports, statements, certificates, and all other documents and records required by law are properly kept and filed; and

(e) in general, perform all duties incident to the office of Secretary and such other duties as may from time to time be assigned to him by the Chairman or the Board of Trustees.

Section 11. Consultants. The Board may utilize or employ such consultants for itself or for its Sanitary Engineering Specialty Committee as it shall deem necessary in order to establish the standards of proficiency

required, and to conduct the examinations to determine the fitness for certification in the field of sanitary engineering or any subdivision thereof. Such consultants shall be outstanding in the field or fields in which they are utilized. Selection of consultants shall be made only by a majority vote of the whole membership of the Board, voting by ballot, or otherwise by a unanimous vote of all members present, a quorum being present, as defined in the bylaws.

Section 12. Salaries. The salaries of the consultants and employees of the Corporation shall be fixed from time to time by the Board of Trustees; but no officer who is also a trustee of the Corporation shall receive any salary or other compensation for his services as such officer.

Article V: CONTRACTS, CHECKS, DRAFTS, BANK ACCOUNTS, ETC.

Section 1. Execution of Contracts. The Board of Trustees may authorize any officer or officers or agent or agents of the Corporation to enter into any contract or execute or deliver any instrument in the name and in behalf of the Corporation, which authorization may be general or confined to specific instances. Unless so authorized by the Board, no officer, agent, or employee shall have any power or authority to bind the Corporation by any contract or engagement or to pledge its credit or to render it pecuniarily liable for any purpose or to any amount.

Section 2. Loans. No loan shall be contracted on behalf of the Corporation and no negotiable paper shall be issued in its name unless authorized by the Board of Trustees.

Section 3. Checks, Drafts, etc. All checks, drafts, and other orders for the payment of money shall be signed or endorsed by such officer or officers of the Corporation and in such manner as shall from time to time be determined by resolution of the Board of Trustees.

Section 4. Deposits. All funds of the Corporation not otherwise employed shall be deposited from time to time to the credit of the Corporation in such banks and other depositaries as the Board of Trustees shall designate or select.

Article VI: CERTIFICATES OF SPECIAL KNOWLEDGE IN SANITARY ENGINEERING

General. The Board shall have power, in its discretion, in the name of and in behalf of the Corporation, to grant and issue, to any person found to be entitled as provided in this Article VI to receive the same, a certificate of special knowledge in any field of Sanitary Engineering. A Certificate shall not be granted or issued by the Corporation to any person unless and until he shall have made application therefor, and shall have been found to be entitled to receive the same, under and in accordance with the provisions of this Article VI.

Section 1. Procedure.

1. Applications. Applications for certificates must be made on the prescribed form, which must be wholly completed and fully documented. Forms for making applications may be obtained from the Board. The completed application must be filed with the Board not less than 120 days prior to the date of the examination.

2. Application and Examination Fees. The fee for making the application shall be ten dollars ($10), which must accompany the application and is not refundable. The fee for the examination shall be twenty-five dollars ($25), which must be paid on acceptance by the Specialty Committee of the application, and not less than 60 days prior to the examination. Applicants who are accepted for examination by the Board, but who fail to appear, will be considered for examination under the provisions of paragraph 3 below. The examination fee will not be refundable, but in case the applicant fails to appear for the examination, or fails in the examination, an additional examination fee will not be charged for said initial or re-examination, or initial examination in the case of an applicant who fails to appear for his first examination.

3. Re-examination. Re-examination will be granted to candidates failing the first examination. Such re-examination (or, in the case of an applicant failing to appear for the initial examination) shall be held within a period of 18 months following the first or initial examination. The Board, as it deems necessary, may or may not require the filing of another application (for which there shall be no additional charge). If the applicant fails the second examination, he may take a third examination, without any additional charge, provided the Specialty Committee approves this third examination; and further provided that a period of at least twelve (12) months has elapsed since the second failure.

4. Annual Fees. Applicants who are certified under Section 4 and Section 5 of Article VI of these bylaws shall pay an annual renewal fee of five dollars ($ 5).

Section 2. Requirements.

Requirements for eligibility for examination shall be both general and special in nature:

1. General Requirements. a. The applicant shall be of good moral character and of high ethical and professional standing.

b. The applicant must be a graduate of a college acceptable to the Board, and must possess a degree in engineering or its educational equivalent, which, when combined with his experience in his chosen field of work, shall be acceptable to the Board; and he must meet the definition of sanitary engineer approved and adopted by the American Sanitary Engineering Intersociety Board, Incorporated.

c. He must have a license to practice engineering.

d. He must have had at least eight (8) years of engineering experience in one or more phases of sanitary engineering following graduation from college.

2. Special Requirements. The applicant must have had at least four (4) years of responsible charge of work in sanitary engineering, which work must include active participation in responsible design, management, research, administration, or teaching with responsibility primarily in the field of sanitary engineering in an educational institution of recognized standing.

Section 3. Examination and Re-examination.

Examinations will be held from time to time and in such places as are indicated by the number of applications received and determined by the Specialty Committee. So far as possible, geographical locations will be selected so as to minimize travel on the part of all concerned.

The examination will consist of three parts:

a. A written examination covering the knowledge of the applicant in the broad field of sanitary engineering, including the principles of public health and their application.

b. A written examination designed to test the knowledge and ability of the applicant in the field in which he claims special proficiency.

c. Appearance before the Sanitary Engineering Specialty Committee or its representative or representatives, with an accompanying oral test to develop fully and satisfactorily the qualifications of the applicant. This oral test will ordinarily be held at the time of the completion of the written examinations and special endeavors will be made to adapt the questions to the applicant's specific experience and work.

Where possible, re-examinations will be scheduled to coincide with normally planned examinations and procedures will be similar in all cases.

Section 4. Certification.

Upon satisfactory completion of the examination and upon recommendation by the Sanitary Engineering Specialty Committee that the applicant meets the prescribed standards, the Board will issue a suitable Certificate. This certificate, which will be signed by the officers of the Board and will have the seal of the Board affixed, remains the property of the Board, but the person to whom it is issued is entitled to its possession unless and until it is revoked. A certificate may be revoked at any time for evidence of fraud or dishonesty, misrepresentation or concealment of facts in the application; or for the revocation of the engineering license issued to him or for the failure to pay the annual renewal fee.

Section 5. Certification without Examination.

Registered professional engineers who have had a minimum of fifteen (15) years of practice and have achieved a high standing in sanitary engineering may be excused from examination. For this certification without examination, application must be made on the prescribed form before July 1, 1957, and the full application, examination, and annual fees must be paid, even though the examination is waived. Applicants under this category may be accepted by the Board, in its judgment, whether or not they meet fully the eligibility and educational requirements previously listed.

Article VII: AMERICAN ACADEMY OF SANITARY ENGINEERS.

The applicant upon certification becomes a member of the American Academy of Sanitary Engineers and is entitled to have his name carried on the roster of the Academy, which roster shall be maintained by the American Sanitary Engineering Intersociety Board and shall be revised at least annually to include the members who are in good standing.

Article VIII: AMENDMENTS.

The bylaws of the Corporation may be altered, amended, or repealed in any particular, and new bylaws may be adopted, in each case not inconsistent with any provision of law or of the Certificate of Incorporation, either (1) by the affirmative vote of a majority of the members at a regular meeting, or at a special meeting of members the notice of which shall include the

form of the proposed alteration, amendment, or repeal or of the proposed new bylaws or a summary thereof, or (ii) by vote of a majority of the whole Board of Trustees at any meeting thereof, the notice of which meeting shall include the form of the proposed alteration, amendment, or repeal or of the proposed new bylaws or a summary thereof, or (iii) by the unanimous vote of all the trustees present at a meeting of the Board of Trustees at which a quorum is present; provided, however, that this Article VIII may not be altered, amended, or repealed by the Board of Trustees and may be amended, altered or repealed only by the members in the manner provided in clause (i) hereof; and provided, further, that any bylaws adopted, altered, amended, or repealed by the Board of Trustees may be altered, amended, or repealed by the members in the manner provided in said clause (i).

This Section of the Journal is provided for the benefit of all members and must have contributions from all. Send news items or contributions to any one of the following:

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We still need Assistant Editors that will report news from the New England Area, Southwest Area and the Northwest. Any volunteers?

PROCEEDINGS PAPERS

The technical papers published in the past year are identified by number below. Technical-division sponsorship is indicated by an abbreviation at the end of each Paper Number, the symbols referring to: Air Transport (AT), City Planning (CP), Construction (CO), Engineering Mechanics (EM), Highway (HW), Hydraulics (HY), Irrigation and Drainage (IR), Power (PO), Sanitary Engineering (SA), Soil Mechanics and Foundations (SM), Structural (ST), Surveying and Mapping (SU), and Waterways (WW) divisions. Papers sponsored by the Board of Direction are identified by the symbols (BD). For titles and order coupons, refer to the appropriate issue of "Civil Engineering." Beginning with Volume 82 (January 1956) papers were published in Journals of the various Technical Divisions. To locate papers in the Journals, the symbols after the paper numbers are followed by a numeral designating the issue of a particular Journal in which the paper appeared. For example, Paper 861 is identified as 861 (SM1) which indicates that the paper is contained in issue 1 of the Journal of the Soil Mechanics and Foundations Division.

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c. Discussion of several papers, grouped by Divisions.

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